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JPRS 83844

8 July 1983

USSR Report

ENGINEERING AND EQUIPMENT

No. 95

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No. 95

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MECHANICS OF AIRCRAFT MANEUVERING WITH ROTATION OF PROPULSION SYSTEM THRUST VECTOR

OBRAZTSOV, I. F., academician, PAVLENKO, V. F. and NELYUBOV, A. I., Air Force Engineering Academy imeni N. Ye. Zhukovskiy, Moscow

[Abstract] The propulsion system of vertical-takeoff-and-landing (VTOL) aircraft as a rule includes life-and-cruising engines with rotation of the thrust vector upward by an angle of greater than $\pi/2$ from the aircraft's longitudinal axis. Modifications of the rotating device make it possible to employ variation of the engine's thrust vector for purposes of improving maneuvering in flight. The rotating device can be used as a new aircraft control, enabling considerable improvement of braking and diving characteristics, reduction of the dimensions of three-dimensional maneuvers and the possibility of separate control of the angle of attack, pitch and mechanical trajectory at the expense of some increase in the weight of the propulsion system and in fuel consumption for a maneuver. The takeoff and landing characteristics of VTOL's are also improved considerably by the rotating devices of lift-and-crusing engines, which even enable point takeoffs. The rotating device makes it possible to perform a number of new maneuvers not possible for an aircraft without variation of the thrust vector in flight and also helps to improve the accuracy of following an assigned path and of guiding the aircraft's longitudinal axis toward its target. Rotation of the thrust vector upward from the aircraft's longitudinal axis enables an increase in the normal load factor and in the available tangential load factor. Increasing the magnitude of the negative tangential load factor by rotating the thrust vector is advantageous in performing maneuvers whose purpose is a reduction in total mechanical energy of the aircraft, including maneuvers such as straight deceleration, diving and roll-and-descend. The effectiveness of horizontal braking achieved by rotation of the thrust vector is 2.0- to 2.5-fold higher with respect to time and distance traveled than when braking by means of air brakes when the propulsion system operates in the low-gas mode. Such strong braking is made possible that the aircraft's flight speed does not increase even in a steep dive. Rotation of the thrust vector, however, complicates piloting of the aircraft. Figures 4, references 1 Russian.
[108-8831]

MARINE AND SHIPBUILDING

UDC 629.12.035.2

ELECTROHYDROJET PROPULSION FPR SHIPS

BARANOV, A. P., KUZNETSOV, S. Ye. and POPOV, Yu. V.

[Abstract] Electrohydrojet propulsion systems combining the functions of
engine and propeller screw are very much under consideration for large-
displacement high-speed sea vessels to be developed during this and the
next decade. Of particular interest are electromagnetic hydrojet drives
using either induction or conduction machines, those with direct reaction
(without intermediate working medium) being simplest in construction in
channel or open-field version. Design and performance calculations for
such drives are based on the principles of MHD power conversion and thrust
generation, the basic relation being $P_{mech} = uFV$ (u- ship velocity, F- electro-
magnetic body force, V- volume of working liquid) and the empirical constant
which determines the specific thrust being $\sigma B = 500$ T/(ohm·m) (σ- electrical
conductivity of sea water, B- magnetic induction in engine channel). Here
calculations are shown for a d.c. MHD conduction machine with uniflow
channel construction. They include the output characteristics (hydraulic
and electrical efficiencies, power delivered) as functions of governing
engine dimensions (channel length), ship velocity, ratio of water velocity
at channel exit to ship velocity, and electrical conductivity of sea water,
at a magnetic induction in the engine channel ranging from 10 to 20 R. A
comparative evaluation of several versions for 25-500 MW high-speed ship
drives indicates that a system consisting of reactor, MHD generator, com-
pressor driven by turbine or electric motor, and MHD propeller offers a
weight and volume advantage of 1.5 and 2 respectively over a conventional
propulsion system. Figures 8, references 3 Russian.
[111-2415]

SELF-CENTERING ELASTIC BEARING SUPPORTS FOR SHAFT EXTENSIONS ON SHIPS

VYAZOVOY, Yu. A. and GARASHCHENKO, P. A.

[Abstract] Elastic bearing supports improve both reliability and flexibility of the engine-shaft system on ships. An example is the bearing support installed in "Kaspiy" fishing-refrigerating vessels. It consists of a cylinder and a plunger coupled by a bellows with rubber backup, a rubber spring washer for protection in case of bellows failure, and a nut for regulation of the clearance. The plunger has two cavities, one in its head containing compressed air and one in its stem filled with a 1:12 alcohol-glycerin mixture, connected by a hole drilled through the wall between them. The bellows cavity is filled with the same fluid mixture and connected with the cavity in the plunger stem through a capillary tube. The bellows is the key element of such a bearing support. It is made of 36NKhTYu alloy with rubber backup, having been designed, selected, and tested for both static and fatigue strength. Use of such supports facilitates assembly of shaft extensions on the ship without the aid of dynamometers for proper centering, they can produce nominal loads on the bearings and compensate nonparallelism between bearing and ship foundation. They stabilize the reaction forces statically under any operating conditions and retain the vibration characteristics of the shaft drive dynamically. The rubber backup extends the life of a bellows to at least four years. Figures 5, references 8 Russian. [111-2415]

OPTIMIZATION OF AUTOMATIC CONTROL OF MARINE ENGINES

ANTONOVICH, S. A.

[Abstract] Optimization of automatic control generally is subdivided into two groups of problems, those pertaining to transient processes of regulating any one parameter and those pertaining to operational processes in the plant. From this standpoint, optimization of automatic control is discussed as it applies to marine engines, with emphasis on correct choice of regulated parameter and precise definition of the optimality criterion, usually in the form of an integral functional of one or several functions. Optimization here is treated as a variational problem with conflicting constraints and thus requiring a tradeoff for optimum system synthesis. These concepts are illustrated in two examples of optimization of automatic control of a diesel engine on a river steamship. In the first case the ship velocity is optimally decreased through regulation of the fuel rate upon entrance

into the harbor. In the second case the ship velocity is optimally regulated through adjustment of the propeller pitch. The propeller speed is involved in each case and the optimization problem is found to be a multicriterial one. Figures 2, references 5 Russian.
[110-2415]

NUCLEAR ENERGY

AUTOMATED SYSTEM FOR CONTROLLING TECHNOLOGICAL PROCESSES OF UNIFIED NUCLEAR POWER PLANTS

SHAL'MAN, M. P., engineer, Atomteploelektroproyekt

[Abstract] An automated control system has been developed for a series of
unified nuclear power plants which is slated for introduction at Power-
Generating Unit No 1 of the Zaporozh'ye Nuclear Power Plant. The "Titan-2"
computing and data processing complex has been developed by TsNIIKA [State
All-Union Central Scientific Research Institute of Total Automation],
utilizing SM [International System of Small Computers] computers in a 3-
level structure. At the first level an M-64 is used for reception and
primary processing of signals, and an SM-1 computer as a concentrator at the
second level, and four SM-2M computers at the third level to perform the
role of computing devices. The underlying concept of the system calls for
automatic control of safety systems and functionally related groups of
equipment, maintenance of process parameters within prescribed limits and
the protection of equipment, as well as the ability for individual devices
to be controlled by an operator from an individual control station. Elements
of the main electrical system are controlled from a central control panel,
the power-generating unit's equipment and elements from a power unit con-
trol panel, the power-generating unit's equipment and elements from a power
unit control panel. A standby control panel is provided to control equip-
ment and elements making it possible to shut down the reactor and cool it in
an emergency if this cannot be done from the power unit control panel.
Local control panels are provided for equipment of the power plant's
auxiliary sections, such as the special water decontamination section. The
ASU TP's [automated system for controlling technological processes] functions
are implemented by individual subsystems. The information subsystem gathers
primary information and reads it out on indicators, printers and CRT's.
The automatic regulation subsystem maintains process parameters within pre-
scribed limits, e.g., the water level in steam raisers. The automatic con-
trol subsystem starts and stops functional groups according to a prescribed
program, e.g., the turbine feed pump. Individual types of equipment are
automatically shut off by the process safety subsystem. The reactor safety

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and control system regulates the reactor's output and shuts it down if
necessary. An intrareactor monitoring subsystem monitors the state of the
reactor's core, and a radiation safety subsystem monitors the integrity of
the primary circuit and the radioactivity of the primary coolant. A signaling
subsystem issues audible and light signals. The power unit control panel
together with the operator unite all these subsystems into a unified automated
system for controlling the nuclear power plant system. The representation
of key information on CRT's and utilization of the functional group principle
represent a newly employed method of organizing monitoring and control of a
nuclear power plant power-generating unit. Figures 4.
[118-8831]

COMPLEXON WATER CHEMISTRY OF NUCLEAR POWER PLANT STEAM RAISERS

MONAKHOV, A. S., candidate of technical sciences, Moscow Energy Institute

[Abstract] It is demonstrated that the thermolysis of complexonates is not
an obstacle for using complexons in secondary circuits of nuclear power
plants for the purpose of ensuring cleanliness of the heating surfaces of
steam raisers, and that this process can be used for the purpose of improv-
ing the efficiency and operating reliability of these circuits. The
operating reliability of nuclear power plant steam raisers depends considerably
on proper organization of the water chemistry for secondary circuits. The
water chemistries used at the present time, e.g., ammonia and hydrazine-
ammonia, do not eliminate the formation of deposits of corrosion products on
a steam raiser's heat transfer surfaces. Corrosion products are formed through
the whole section from the steam trap to the steam raiser. There are no
coarsely dispersed corrosion products in the feed water, but they appear in
the water of the steam raiser as the result of evaporation and the negative
temperature coefficient of solubility. Complexons can be used to prevent
the formation of deposits in steam raisers both with and without a steam
trap. Impurities are converted to the dissolved state in the form of
complexonates. The impurities dissolved in the steam raiser's water are
removed from the cycle with the blowdown water. In medium-pressure steam
raisers with stainless or pearlitic steel pipes magnetite films occur in the
process of thermal decomposition of complexonates of iron. If the complexon
is dispensed into the feed pipe after the high-pressure heater, only complexon-
ates of iron will enter the steam raiser and their thermolysis will take place
with the formation of protective films in the steam raiser. Data on concen-
trations of iron in the water of steam raisers with complexon and ammonia
water chemistries are compared, whereby it is shown that iron is concentrated
more strongly in the boiler water with a complexon process and the percentage
of iron in the dissolved state is considerably higher. In the thermolysis of
complexonates in 3.2- and 5.2-MPa steam raisers secondary products of thermolysis

form, which have higher thermal stability and maintain impurities in the suspended state. Figures 2, references 3: 2 Russian, 1 Western.
[120-8831]

STUDY OF LEVEL CHANGE IN NUCLEAR POWERPLANT CONDENSER BUBBLERS

ANTROPOV, V. N., graduate student, engineer, and BUKRINSKIY, A. M., candidate of technical sciences, All-Union Institute of Heat Engineering

[Abstract] To plan bubbler condensers properly, one must know the behavior of the swelling layer during unstable bubbling as a function of flow rate and parameters of the medium at the input. Studies were performed on an installation consisting of a steam preparer connected before the experimental section to accumulate the necessary quantity of saturated steam-water mixture before it was released into the bubbler. Visual observation and motion picture photography were performed through inspection windows. A series of experiments was performed on this installation for initial water levels of 500 and 1000 mm characteristic for actual bubblers and various maximum bubbling speeds of 1.6 to 5.0 m/s. The water volume swelling process in bubblers occurs in three stages. In the first stage two zones are formed with a water plug above a two phase zone. In the second stage the plug disappears and a transient two phase layer is formed. Finally, the level gradually drops. The inertia of the bubbler layer and variation in true layer as a function of condensing steam flow as water temperature rises must be computed to design bubblers accurately. Figures 6, references 9: 6 Russian, 3 Western.
[153-6508]

INFLUENCE OF HYDROGEN ON BRITTLE FRACTURE TENDENCY OF WELDED VVER-1000 NUCLEAR REACTOR BODY JOINTS

MAZEL', R. Ye., candidate of technical sciences, GRINENKO, V. G., KUZNETSOVA, T. P. and SAPRONOVA, M. N., engineers, All-Union Institute of Heat Engineering

[Abstract] A study is made of the influence of hydrogen on the brittle fracture tendency of various zones in welded joints at a pressure of 12 MPa for various operating temperatures, deformation speeds and hydrogen concentrations. Welded joints in type 15Kh2NMFA steel sheels were studied.

Electrolytic hydrogenation was used. Tests of flexural strength before and after hydrogenation indicate that the hydrogen embrittlement resistance can be increased by decreasing the content of harmful impurities (antimony, tin, arsenic, zinc, lead) in the base metal and welding wire. The internal surface of reactor bodies should be clad with austenitic steel to prevent hydrogen embrittlement. Figures 6, references 8: 7 Russian, 1 Western.
[153-6508]

EXPERIENCE IN HYDRAZINE MODE START UP AT KOLA NUCLEAR POWERPLANTS

MAMET, V. A., candidate of technical sciences, NAZARENKO, P. N., IGNATENKO, N. M, engineers, PASHEVICH, V. I., candidate of technical sciences, TITARENKO, A. P., RUSSAKOVA, A. K. and TROFIMOV, B. A., engineers, All-Union Scientific Research Institute of Nuclear Powerplants, Kola Nuclear Powerplant

[Abstract] Up to 1981 the Kola Nuclear Powerplant utilized a hydrazine-ammonia water mixture with hydrazine and ammonia input after the deaerator. Corrosion rates were rather high using this mixture. This article reports on a test begun on February of 1981 in which two power units received hydrazine in the low pressure section without ammonia. The concentration of copper subsequently found in the water flowing out of the unit was significantly lower indicating much reduced corrosion rates. A system for automatic dosage of hydrazine based on E_{pt} is needed to fully realize the advantages of the hydrazine mode. Figures 5, references 8 Russian.
[153-6508]

TEST STAND OPERATION OF EXPERIMENTAL EVAPORATIVE CHANNELS FOR FIRST POWER UNIT OF BELOYARSK NUCLEAR POWERPLANT

TYURIN, V. N., GASHENKO, V. A., GORYACHKIN, I. N., AKIMOV, I. I., engineers, and PLYSHEVSKIY, M. I., candidate of technical sciences

[Abstract] Results are presented from long term tests and studies after testing of shortened experimental evaporator channels (models) of zirconium alloy. The studies were performed on a special test stand creating specific conditions close to the operating conditions of evaporative channels in the first Beloyarsk nuclear powerplant power unit in terms of composition and

parameters of the medium, but without radiation. Two models of evaporative channels with tubes made of an alloy of zirconium with 2.5% niobium were tested over a period of 18,000 hours. No leaks were observed during the test time. The outer surface was covered with a black oxide film after 18,000 hours, indicating the high corrosion resistance of the alloy. Internal steam pressure was 16.9 MPA and the temperature 350°C. Figures 2, references 4 Russian.
[153-6508]

VERTICAL DIRECT FLOW STEAM GENERATOR FOR VVER-NUCLEAR POWERPLANT

GLEBOV, V. P., doctor of technical sciences, MOSKVICHEV, V. F., SIMKIN, B. P., engineers, ESKIN, N. B., candidate of technical sciences, ARTEMOV, L. N., engineer, GREBENNIKOV, V. N., candidate of technical sciences, ULASOV, V. M., engineer, TERENT'EV, I. K., candidate of technical sciences, MARINICH, A. M., engineer, SHVARTS, A. L., doctor of technical sciences, GODIK, I. B. and Building Plant imeni Ordzhonididze, Scientific-Production Union Central Boiler and Turbine Institute, All-Union Institute of Heat Engineering, Special Design Office of All-Union Institute of Heat Engineering

[Abstract] A study is made of the simplest design of a direct flow 500 MW (el) steam generator with straight heat exchange pipes and rigidly mounted pipe screens in which temperature elongation difference compensation is achieved by assuring the optimal mean temperature through the height of the body by fully defined placement of feed water pipes and superheated steam exhaust pipes. The major characteristics of the steam generator corresponding to nominal load, as well as design and dimensional characteristics, are presented. A diagram of the steam generator is presented. The extensive experimental and calculation material reported indicates the correctness of engineering decisions made both in the thermal-hydraulic system and in terms of the structural materials selected. Figures 5, references 4: 3 Russian, 1 Western.
[153-6508]

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TECHNICO-ECONOMIC MODEL OF CENTRALIZED HEAT SUPPLY SYSTEM ON BASIS OF AES

YAKOVLEV, B. V., candidate of technical sciences, GLYUZA, A. T., engineer,
MINICH, E. P., engineer, and SYROPUSHCHINSKIY, V. M., engineer, Belorussian
branch, All-Union Scientific Institute of the Power Industry

[Abstract] A functional model of a centralized heat supply system has been
constructed, including a set of calculation programs, which will make it
possible to correlate mathematical theory with practical application in terms
of technical and economic performance indicators. The basic heat source in
this model is an AES delivering 2-6 MW of electric power, with peak heat
loads covered by boilers running on solid or gas-oil fuel. An alternative
variant is a separate heat supply system operating with either fossil or
nuclear fuel. Calculations for the model include annual heat consumption
curves, normalized cost of peak boiler power, design of thermal system around
a turbine, normalized cost of underproduction of electric energy in loop
closing plant, normalized cost of heat transporting ducts, normalized cost
of reconstructing the AES and of adding station auxiliaries for harnessing
the heat, and normalized cost of centralizing the heat supply system in an
AES. The program complex is a modular one so that subroutines can be modified
or exchanged, as necessary, for any type of basic power station and heat
supply system. Figures 1.
[155-2415]

SOME RESULTS OF EXPERIMENTAL STUDIES PERTAINING TO OPERATION OF VVER-1000
WATER-MODERATED WATER-COOLED POWER REACTOR UNIT WITH SLIDING INITIAL STEAM
PRESSURE

IVANOV, V. A., doctor of technical sciences, professor, IGNATENKO, Ye..I.,
candidate of chemical sciences, KULIKOVA, G. G., candidate of technical
sciences, BOROVKOV, V. M., candidate of technical sciences,
MIROSHNICHENKO, M. I., engineer, and BOLDYREV, N. V., engineer, "Order of
Lenin" Leningrad Polytechnic Institute imeni M. I. Kalinin, All-Union
Administration of Atomic Energy, and Novo-Voronezh AES

[Abstract] After the feasibility of operating clad reactors in a power plant
under sliding steam pressure in the second loop had been established
theoretically, an experimental study of this method of power regulation was
conducted first on one VVER-440 MW reactor in the Kola AES. The positive

results and further theoretical evaluation prompted a more extensive second study, this time on the VVER-1000 MW reactor No. 5 in the Novo-Voronezh AES. The objectives of this experiment were firstly to verify the possibility of operating both first and second loops with lower steam pressure in the second loop and with fully open regulator valves of both turbines, secondly to determine the advantages of changing to lower pressure in the second loop from the standpoint of heat economizing in the steam turbines and energy saving in operation of the feed pumps. Measurements of electric power (by the two-wattmeter method), pressure, temperature, and servomotor travel were accurate within respectively 0.2%, 0.5%, 0.5°C, and 2 mm, at a constant line frequency in the electrical power network. Tests were performed with the automatic power regulator, the protective underpressure relay, and the automatic feed water regulator in the main pump channel cut out. The results of this experiment were also positive, sliding the initial steam pressure with fully open regulator valves having been found to increase the internal efficiency and improve the heat economy under partial loads. The operating conditions in the reactor core are improved as well, on account of a lower mean temperature of the coolant in the first loop resulting in a larger margin of reactivity and a wider range of regulation. Figure 1, references 5 Russian.
[155-2415]

OUTLOOK FOR USING GAS-TURBINE UNITS IN FACILITIES WITH HIGH-TEMPERATURE GAS-COOLED REACTORS

BEKNEV, V. S., LEONT'YEV, A. I., doctors of technical sciences,
SUROVTSEV, I. G. and SHMIDT, K. L., candidates of technical sciences

[Abstract] An analysis of the prospects for using gas-turbine units for thermal-to-electrical conversion in high-temperature gas reactors with helium-cooled core. Three prototype experimental-industrial reactors have been developed in the USSR: VGR-50, VG-400 and VGR-300 with electric power of 50, 400 and 300 MW respectively. On the first phase of construction, these reactors will use conventional steam turbines to generate electric power. Research has been done at Moscow Higher Technical Academy imeni N. E. Bauman on effective designs of closed-cycle gas-turbine units on helium for use with these reactors. Preliminary results show that further research and development should be done in two stages: 1. analysis of gasdynamic, thermal and strength characteristics in a loop with fossil-fuel heating of helium; 2. final analysis of the characteristics of a closed-cycle gas-turbine unit in a loop with the actual reactor core. Figures 4, tables 3, references 7: 4 Russian, 3 Western.
[147-6610]

ROLE OF PHYSICAL FAST REACTOR CHARACTERISTICS IN LIMITING CONSEQUENCES OF HYPOTHETICAL ACCIDENTS

KUZNETSOV, I. A., BAGDASAROV, Yu. Ye. and ASHURKO, Yu. M.

[Abstract] An analysis is made of the consequences of accidents with failure of the main circulating pumps of fast reactors accompanied by failure of emergency protection. An examination is made of the influence that physical and thermophysical reactor parameters have on maximum deviations of temperatures. The authors discuss the feasibility of reducing reactor power in the mode of self-regulation by utilizing negative effects of reactivity and going to conditions of natural circulation without boiling of the coolant in the core. Figures 2, references 5 Russian.
[148-6610]

KINETICS OF TWO TIGHTLY COUPLED PULSED REACTORS

BUGROV, V. N. and KARAMYAN, S. A.

[Abstract] An examination is made of transient processes on prompt neutrons that take place in two coupled pulse reactors, where the kinetics of each of them can be described in a one-point approximation. Expressions are derived for the intensities of fissions in the reactors, and relations are given for the integral parameters of fission pulses (total number of fissions per pulse, maximum intensity of fissions, pulse half-width) in terms of one another, and in terms of the analogous one-point parameters for the case of a strongly coupled reactor system. The results show that the kinetics of a system of strongly coupled reactors can be described in the one-point approximation under certain conditions. References 7: 5 Russian, 2 Western.
[148-6610]

COMPARATIVE NEUTRON-PHYSICS CALCULATIONS OF FAST REACTORS

YORDANOV, Y. D. and ANTONOV, N. A., Institute of Nuclear Research and
Nuclear Power, Bulgarian Academy of Sciences, Sofia

[Abstract] On the basis of the formalism of self-shielding factors, the
Institute of Nuclear Research and Nuclear Power of the Bulgarian Academy of
Sciences has developed the PRIDAN program for determining effective cross
sections of media typical of fast reactors. The input data are obtained by
using a library of multigroup constants for fast reactors. The output data
of the PRIDAN program can be formulated as input data for a variety of
programs of neutron-physics calculation of fast reactors written in FORTRAN-
IV. Calculations are done for a standard fast reactor that is a simplified
spherical model of a fast sodium-cooled power reactor with oxide fuel.
Results of the calculations are given for neutron balance, characteristics
of plutonium breeding, and influence of capture cross section for ^{239}Pu
fission products. Some results of calculation of the MASURCA reactor are
presented. Tables 7, references 14: 2 Russian, 6 Bulgarian, 1 Rumanian,
5 Western.
[148-6610]

STRUCTURE OF PROGRAM FOR CONTROLLING START OF STEAM TURBINE TAKING INTO
ACCOUNT VARIATION IN ELONGATION OF ROTOR

POKHORILER, V. L., candidate of technical sciences, GALIMULIN, N. N. and
SHLOPAK, L. A., engineers, Ural Polytechnical Institute

[Abstract] Elongation of the rotors of high-temperature cylinders is a
critical parameter determining the permissible starting rate for high-power
turbines operating on superheated steam. Restrictions on elongation of the
high-pressure and medium-pressure rotor in starting the K-500-240-2 turbine,
in particular, make it necessary to include a "Rotor Elongation" subprogram
in the program for design formation of an assignment for altering the
steam's temperature in optimization of control of the startup of a 500-MW
power generating unit by means of an automated control system. This sub-
program must be based on equations for the dynamics of the change in the
elongation of rotors, δ, as a function of the temperature of the steam in
front of the individual cylinders or at representative points of the flow-
through section of individual cylinders or at representative points of the
flow-through section of individual cylinders. Difficulties in deriving these
equations are associated with the sluggishness of δ and with the considerable
influence on its change of initial conditions, such as the instantaneous
thermal state of the rotor and stator of the turbine cylinder. The
principles of the structure of this subprogram are discussed. An equation
is given, expressing the relationship between instantaneous values of the
mean-mass temperatures of the cylinder's rotor and stator and the elongation,
taking into account the coefficients of linear elongation of the metal of
the rotor and stator, the length of the rotor and stator in the cold state
with zero elongation of the rotor, and the change in the elongation of the
rotor under the effect of centrifugal forces at a given rotational velocity
of the rotor. Equations are found, expressing the dynamic relationship
between mean-mass temperatures and the temperature of the steam at a
representative point of the cylinder's flow-through section. For a high-
pressure cylinder this temperature is as a rule the temperature of the steam
behind the regulating stage and for a medium-pressure cylinder, the
temperature of the steam directly in front of the cylinder. The amount of
measurements used in the process of solving the problem in an automated

control system is minimized by expressing mean-mass temperatures in terms of mean temperatures in one or two sections. The temperature of the casing averaged for the thickness of the wall in the exhaust area was used for this purpose. The casing wall and the flange are used as two representative elements in analysis of the dynamics of heating of the stator. Equations are derived which make it possible to determine the value of the temperature of the steam flowing around the rotor with which the elongation of the rotor will be equal to its assigned value. The equations derived were used to develop an appropriate subprogram for the automated control system for a 5-MW power generating unit with a K-500-240-2 turbine. Figures 3, references 4 Russian.
[120-8831]

USE OF SOLAR ENERGY TO PRODUCE LOW POTENTIAL HEAT

VALOV, M. I., engineer, Moscow Institute of Power Engineering

[Abstract] The design of a solar collector for the production of low potential heat, such as might be used for rural heating of domestic hot water, is described in general terms. Simple equations are presented to evaluate the operation of such a heating system. The data presented indicate that the characteristics of existing solar collectors are satisfactory and allow genuine fuel savings to be achieved by the use of solar energy for partial winter heating and total summer hot water supply. The substitution factor depends on many variables, particularly the area of solar collectors, intensity of solar radiation, heat supply system load and solar collector parameters. Therefore, determination of the characteristics of a solar heating installation requires analysis and calculation based on the specific characteristics of each individual system. The equations presented allow this task to be performed and the savings of natural fuel by the use of solar energy in various regions of the country to be determined. Figures 3, references 3: 2 Russian, 1 Western.
[164-6508]

STUDY OF PNEUMOTRANSPORT SYSTEMS

VTYURIN, Yu. N., engineer, National Institute of Heat Engineering

[Abstract] Pneumotransport systems were studied to optimize transportation conditions for coal powder of various particle sizes at regional electric powerplants. Studies were performed in a 250 mm diameter pipe 350 m in length with an air transportation medium. The equations are presented for the head loss involved in accelerating the coal and the coefficient of friction of the flow with the walls of the pipe. Increasing the velocity was found to increase the Reynolds number which decreased friction. Pneumotransport was found to represent a small fraction of the total cost of powder preparation. The economy of pneumotransport can be best improved by decreasing the air flow per unit volume of coal transported. Cast stone pipe sections should be used at turns, since they wear out much more rapidly than straight horiz ntal pipe sections. The service life of valves on pipes has now been increased to one year. Figures 4, references 3 Russian. [152-6508]

INFLUENCE OF CLIMATIC FACTORS ON OPERATION AND POWER INDICES OF HEAT SUPPLY SYSTEM EQUIPMENT

ARSHAKYAN, D. T., candidate of technical sciences, Armenian Scientitic Research Institute Power Engineering

[Abstract] A study is made of the influence of climatic factors on operating conditions and energy indices of heat supply turbines. The most important factors determining the effectiveness of city heat supply are determined by the amount of heat taken from the heat and electric powerplant, and are influenced by climatic factors. A detailed investigation was undertaken to determine the regularities involved in changing energy indices under various climatic conditions. The variations involved are complex, but the climatic factors have a particularly great influence on the economic effectiveness of centralized heat supply, since in warmer areas the geographic area covered by centralized heat supply increases greatly, resulting in an increase in the cost of central heat supply networks. Figures 5, references 7 Russian. [153-6508]

SELECTION OF POWER LEVEL OF PRIME MOVERS FOR ELECTRIC GENERATORS

STUKOV, B. I.

[Abstract] Selection of prime movers for electric generators on board of ships is discussed on the basis of experience with the steamship "Ivan Franko" and other vessels. Load levels and fuel consumption as well as ambient conditions and length of service are taken into account in selection of diesel power for generators in various modes of operation. Necessary calculations are aided by nomograms and are based on manufacturer nameplates, additional data taken from the ship log. During the 1979-80 period, for instance, the "Ivan Franko" has been in the Carribean Sea, in the South Atlantic, in the South Pacific, in the Mediterranean Sea and in the Black Sea. Diesel engines with supercharge and electric generators have been supplied from manufacturing plants in the GDR. Overload capacity of prime mover and overload protection of electric generators are also included in the considerations. Figure 1, tables 2, references 3 Russian.
[110-2415]

BASIC THEORY OF CONTROLLABLE POWER REACTORS

DOROZHKO, L. I. and LIBKIND, M. S., Moscow

[Abstract] A controllable power reactor is defined as one whose performance parameters can be varied through bias magnetization. Magnetization can be longitudinal, transverse, or circumferential. Saturable reactors are used for transverse compensation and for limiting voltage oscillations in a.c. transmission lines, such reactors being less costly than reactor-thyristor banks. A main problem with controllable reactors is suppression of network harmonics and self-excited reactor harmonics, by means of stabilizers or filters, or by using reactors with rotating field (3-phase reactors being more expedient than 2-phase ones). The performance of controllable reactors is characterized by control power and response speed. The former can be minimized by avoidance of gaps in the magnetic structure. The latter can be maximized by voltage boosting of the d.c. current source, also by insertion of a resistance into the control circuit. A performance evaluation covers also power losses and their effect on operating costs, transient processes, and asymmetric operation modes. Figures 4, table 1, references 15: 11 Russian, 4 Western.
[154-2415]

CORE-TYPE AND SHELL-TYPE SHUNTING REACTORS WITH NONMAGNETIC GAPS

KOSTRITSKAYA, N. P., candidate of technical sciences, KUTYAVIN, I. D., doctor of technical sciences, professor, and CHESHEVA, T. V., engineer, Gomel Polytechnic Institute, "Order of October Revolution" and "Order of Labor's Red Banner" Tomsk Polytechnic Institute imeni S. M. Kirov

[Abstract] A design study is made of a single-phase 100 MVA-500 kV shunting reactor, for a comparative evaluation of cost and active materials. Two types of construction are considered: a shell construction with uniformly distributed air gap in the core and an armorclad-yoke construction with the gap width equal to the height of the winding window. The dimensions are determined according to standard design formulas, whereupon the weight of steel and copper are calculated. The results reveal that as well-type reactor weighs and costs more (63.4 t and 49,500 rubles), uses more steel (48.4 t) but much less copper (5 t). On the basis of copper economy, it may be preferable to an armorclad-yoke reactor (13.3 t copper, 17.9 t steel, 57.9 t total, 46,000 rubles). Figures 2, table 1, references 2 Russian.
[155-2415]

STOCK MODULES FOR TRAILER HOMES WITH SELF-CONTAINED SOLAR POWER SUPPLY

SAKHAROV, A. N., GOLUBNICHAYA, O. L. and CHISTYAKOVA, V. A., "Order of Labor's Red Banner" Moscow Institute of Architecture

[Abstract] Stock modules for trailer homes with self-contained solar power supply have been developed at the Moscow Institute of Architecture under direction of Professor Yu. N. Sokolov. There are basically two types of modules, one for cooking facilities and one for sanitary facilities. Each includes an array of solar radiation collectors, a set of heat storage tanks, and a heat distribution system. Each module is square in the plan view (3.0 x 3.0 m) and trapezoidal in the elevation view (horizontal parallel sides under inclined roof opposite vertical 6.0 m high container wall). The modules are designed for 6-8-12-24 people in single barrack or with partitioning into several apartments. They are designed for operation in four modes: 1) heating from radiation collector directly; 2) heating from storage tank; 3) storing heat from radiation collector; heating from fueled

booster boiler. The roof (radiation collector) is inclined at a 60° angle, based on maximum utilization of sun in winter. A module can save up to 1134.9 kg of coal or 852.0 kg of oil annually, based on a demand of $6.56 \cdot 10^6$ kcal/yr for hot water supply. Figures 2.
[165-2415]

TRACKING TRANSDUCERS WITH FIBER OPTICS FOR SOLAR POWER PLANTS

SIZOV, Yu. M., KHAKIMOV, R. A., BARANOV, V. K. and ZOLOTARENKO, V. L.,
Central Design and Planning Office of Scientific Instrument Building
UzSSR Academy of Sciences

[Abstract] Several versions of sun tracking photoelectric transducers have been developed by the authors for use in solar power plants. They generate analog signals of mismatch between heliostat orientation and position of the sun. The basic version includes two photoreceivers, for tracking in the zenith plane and in the azimuthal plane respectively, both in a tube behind a shadow shield with an iris over the aperture at the center. Each photoreceiver faces a pair of fiber-optic light guides, one with larger cross section picking up radiation from outside the tube for coarse tracking and one with smaller cross section picking up radiation from the irised aperture through the tube for fine tracking. Transition from coarse to fine tracking occurs smoothly through switching of the light guides. A modification of this basic transducer is constructed for direct mounting on the heliostat. Figures 2, references 6: 4 Russian, 2 Western.
[165-2415]

SIMPLE MATHEMATICAL MODEL OF OPERATION OF SOLAR RADIATION COLLECTOR FOR HEATING SYSTEM IN A BUILDING

NIKIFOROV, V. A., "Order of Labor's Red Banner" Kiev Institute of Construction Engineering

[Abstract] A mathematical model is proposed for describing and evaluating the annual operation of solar radiation collectors in buildings with solar heating system. The model is based on the concept of a "sky" factor, ratio of total solar radiation flux reaching the earth surface to total

solar radiation flux available above the atmosphere, and the concept of threshold solar radiation level. The expression for useful energy developed by a solar radiation collector becomes modified accordingly, both the sky factor and the useful solar radiation level above the threshold appearing as probabilistic quantities under summation which covers n (1-365) days in the year. The model includes four parameters characterizing the climatic conditions, one of them the maximum sky factor and three others depending on the geographical latitude. It also includes a collector design and orientation factor as well as a collector utilization factor. Data for this model have been obtained from measurements at three locations in the Ukraine (Kiev, Odessa, Kara-Dag), normalized to a horizontal surface and a base year, and compared with analogous data for Uzbekistan, Spain and Italy. The distribution of the sky factor $K(n)$ is found to differ asymmetrically and unimodally from a normal one, describable by a Pearson curve of the first kind with 97.3% of all its values falling between a maximum $K(n)^{max}=$ $=0.7-0.8$ and a minimum $K(n)^{min}$ which varies cosinusoidally from 0 to 0.4 over the year. Calculations with the aid of Korobov's recurrence relation for pseudorandom numbers have been made for simulating the operation of three solar radiation collectors of different designs within the 2.68-5.36 W/$(m^2 \cdot K)$ range in the Crimea. Figures 2, references 7: 5 Russian, 2 Western. [165-2415]

EXPERIMENTAL STUDY OF SOLAR REFRIGERATOR

KAKABAYEV, A., KHANDURDYYEV, A. and SHYKHNAZAROV, G., "Solntse" Scientific-Industrial Association, TuSSR Academy of Sciences, Ashkhabad

[Abstract] A solar refrigeration plant has been developed and built by the authors for cooling to near-zero and subzero temperatures under climatic conditions in Turkmenistan in summer. It contains two machines, an LiCl machine for near-zero temperatures and a water-ammonia machine for subzero temperatures, each including a set of pumps, a tubular absorber, and a condenser and evaporator set, both under a solar regenerator-roof. The cold produced in the LiCl stage is used for cooling the water-ammonia condenser and absorber as well as for conditioning the air in two laboratory rooms. The solar regenerator is a 4.80 x 4.48 m rectangular plate inclined at a 10° angle, its lower quarter hermetically covered with glass. The plant was thoroughly tested during the 1980-81 summer periods for overall performance, most important being the daily curves of refrigeration power developed and temperature-time curves characterizing the performance of individual components, with each machine operating alone or with both machines operating together. In the former case the plant develops an hourly mean refrigeration power of 4000 W at +11°C and 1700 W at -8°C. With a mean solar radiation

flux density of 730 W/m^2 at the regenerator-heater surface, the plant efficiency (ratio of developed refrigeration power to incident solar radiation power) is 26% at near-zero temperature and 10% at subzero temperature with the water-ammonia machine only and corresponding 36% and 7% with both machines. Figures 3, references 4 Russian.
[165-2415]

PATTERN OF HEAT LOAD DISTRIBUTION IN HEAT SUPPLY SYSTEM DURING OPERATION OF SOLAR POWER PLANT

VALOV, M. I. and SHOPENSKIY, L. A., "Order of Lenin" and "Order of October Revolution" Moscow Institute of Power Engineering

[Abstract] The distribution of residential load on a solar heating plant has been calculated for the period of plant operation, taking into account seasonal variation of daylight hours and heat demand. The load nonuniformity factor, according to the load curve, increases as the number of individual users decreases. The corresponding decrease of the fraction of total heat supplied by the solar plant (the remainder supplied by a conventional heating plant) depends on the type of users. Data obtained for homes, hotels, schools and nurseries indicate that this variation in solar plant operating hours does not significantly affect the substitution factor. Table 1, references 5: 4 Russian, 1 Western.
[165-2415]

CONSTRUCTION OF EXPERIMENTAL SOLAR STEAM GENERATOR FOR EXPERIMENTAL 5 MW SOLAR ELECTRIC POWER PLANT

ITMAN, D. L., BIRYUKOV, A. A., KHAR'KOV, N. V., LOKSHIN, V. A. and GLADILIN, V. I., All-Union Scientific Research Institute of Heat Engineering imeni F. E. Dzerzhinskiy

[Abstract] The experimental 5 MW tower-type solar electric power plant now being installed in the Crimea is the first one of this size in the Soviet Union. It was designed at the All-Union Scientific Research Institute of Heat Engineering, a circular array of 1600 5 x 5 m^2 large heliostats around a tower at the center with a steam generator on top 70-80 m above ground.

The steam generator has the shape of a vertical regular dekahexahedral prism, with a 7176 mm diameter of the circumscribing circle, its 7000 m high exposed surface receiving 98% of all radiation from the heliostats (average 135 kW/m^2, maximum 225 kW/m^2). Its lateral surface is formed by vertical seamless tube panels made of grade 20 steel, 14 evaporator panels 1330 mm wide (50 x 5 mm tubes with 70 mm spacing) and 2 economizer panels 1334 mm wide (32 x 5 mm tubes with 46 mm spacing) on the less heated southern side, around a 4400 mm long drum with 1200 mm bore diameter and 40 mm wall thickness. With a theoretical total heated area of 157 m^2, the generator produces saturated steam at 4 MPa and 250°C. Its maximum capacity is 28 t/h, its overall efficiency is 81%. Generating saturated rather than superheated steam is preferable from the standpoint of reliability under conditions of intermittent solar energy supply. Natural circulation of steam and water has been found to be adequate and most economical. The steam generator is controlled, equipped with a relief valve, and protected against freezing during winter. It is estimated that in a year, with the sun 15° and higher above the horizon for 3200 h, the power plant will, on the average, operate for 1920 h under favorable conditions: 1708 h (89%) in the March-October period and 213 h (11%) in the November-February period. Figures 3, references 3 Russian.
[165-2415]

SOLAR-FUEL HYBRID ELECTRIC POWER PLANTS BASED ON MARGINAL NATURAL-GAS DEPOSITS IN UZBEKISTAN

UMAROV, G. Ya., Physico-Technical Institute imeni S. V. Starodubtsev, UzSSR Academy of Sciences

[Abstract] Hybrid electric power plants are proposed for operation in Uzbekistan which will combine use of solar energy during bright days and use of natural gas from marginal deposits as fuel during nights and overcast days. Such a plant can operate with high-pressure steam. Operation on this dual base should not only ensure stable and smooth power generation but also combine higher efficiency of solar energy conversion with better fuel economy at a reasonable installation cost. The concept applies to large tower-type solar electric power plants with fuel plant as booster and to small solar electric power plants with individual paraboloidal concentrators. Costwise such a combination is competitive with atomic electric and hydroelectric power generation for this area. Table 1, references 4 Western.
[165-2415]

OPTIMIZATION OF RADIATION CONCENTRATION FACTOR IN SOLAR PHOTOELECTRIC POWER
PLANTS

GRILIKHES, V. A., ZAYTSEV, O. F. and SEKERIN, Yu. N., Leningrad

[Abstract] The feasibility of optimizing a solar photoelectric power plant
is considered ina way which will extend the forward rising side of the
efficiency curve $\gamma = (\gamma)_{K=1} + \gamma \log K$ (K- radiation concentration, γ-
empirical coefficient depending on plant structure) to concentration factors
as high as K = 1000. The optimality criterion for high-concentration plants
is the minimum total cost (converter surface + concentrator surface +
radiator surface) per unit electric power developed. This unit cost is
evaluated on the basis of energy and power relations in the concentrator-
converter system (converter located in the focal plane of the concentrator)
and optimum converter size for minimum energy losses. Temperature dependence
of the converter efficiency is also taken into account, assuming that the
radiator temperature is uniform and equal to the converter temperature over the
entire active surface. Typical data on AlGaAs/GaAs heterojunction cells indi-
cate that the cost per kW can be 50-65 times lower with an optimum concentrator
(K = 300) than without a concentrator. The evaluation procedure allows for
including the cost of launching a plant into space orbit. Calculations were
made by V. A. Sidorova. Figures 2, references 14: 8 Russian, 6 Western.
[165-2415]

PHOTOVOLTAIC SOLAR CELLS OF HETEROJUNCTION TYPE WITH SCHOTTKY BARRIER

AZIMOV, S. A., AKHMEDOV, F. A., MIRTURSUNOV, Sh. and SHUMINOV, R. A.,
Physico-Technical Institute imeni S. V. Starodubtsev, UzSSR Academy of
Sciences

[Abstract] A solar cell with Schottky barrier is considered for operation
with high efficiency at high concentration of solar radiation. Its per-
formance is determined by the configuration of energy bands of the n^+-n^0
structure, the forbidden band of the n^+-layer being much wider than that
of the n^0-layer base, and by presence of a barrier metal on the n^0-layer
which reflects incident radiation. The thickness of the n^0-layer must be
smaller than the length of the diffusion path for excess holes. Then the
carrier collection coefficient will be a function of the n^0-layer thickness,

the latter thus controlling the conversion efficiency of the solar cell. The shortwave edge of photosensitivity is determined by the width of the forbidden band of the n^+-layer receiving the solar radiation. The photosensitivity spectrum can be extended in the long-wave direction, inasmuch as the height of the potential barrier is always smaller than the width of the forbidden band of the n^0-layer semiconductor so that the barrier can be overcome by free electrons of the metal which have absorbed radiation quanta which the n^0-layer has not absorbed. The optimum thickness of this layer is larger than half the penetration depth for radiation quanta with energy approximately equal to the width of its forbidden band, but smaller than the length of the diffusion path for minority carriers. The barrier layer can be thick, which makes it feasible to operate such a solar cell at high current densities without decreasing the form factor of its current-voltage characteristic. Figure 1, references 2: 1 Russian, 1 Western.
[165-2415]

FEASIBILITY OF INCREASING SPECIFIC POWER OF PHOTOELECTRIC CONCENTRATOR MODULES CONTAINING AlGaAs HETEROPHOTOVOLTAIC CELLS

ARIPOV, Kh. K., YEGOROV, B. V., KOROLEVA, N. S., LARIONOV, V. R., NULLER, T. A., RODRIGES, H. A. and RUMYANTSEV, V. D., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences

[Abstract] High-current AlGaAs heterophotovoltaic cells are very suitable for converting concentrated solar radiation energy, if designed for high specific power without loss in efficiency. This requires a high concentration factor, a large surface area, a low internal electrical resistance, and adequate heat dissipation. An experimental study of these four factors and their interrelation was made on epitaxial n-GaAs/p-GaAs/p-Al$_x$Ga$_{1-x}$As structures ($x \sim 0.7$, AlGaAs layer 25-30 μm thick) with Au + Zn contact tabs and with a circular light-sensitive surface surrounded by a current collecting busbar, a surface forming a circular image of the sun being the most effective solar radiation concentrator. Deposition of a photolithographic grid on this surface reduced the distributed component of its electrical resistance, a quantity not depending on the surface diameter, by 2-3 orders of magnitude to a level comparable with that of its lumped component of electrical resistance. Current-voltage and efficiency-current characteristics were measured, with indium-coated contact grids reducing the electrical resistance components to $R_{lump} \sim 6 \cdot 10^{-3}$ ohm·cm^{-2} and $R_{distr} \sim 2 \cdot 10^{-2}$ ohm and with either direct water cooling or indirect cooling by evaporator-siphons. Theoretical calculations (not taking into account thermal effects attending high concentration of solar energy) and experimental data indicate that a module 0.8 cm in diameter with a radial-circular contact grid (15% shielding) can deliver

a power of 20 W at a concentration factor K = 1000 and with passive air-convection heat dumping. Figures 3, references 6 Russian.
[165-2415]

ELECTRODES MADE OF POLYCRYSTALLINE CdSe FOR REGENERATIVE PHOTOELECTROCHEMICAL CONVERTERS

VARDAPETYAN, T. A., ARUTYUNYAN, L. A. and ARUTYUNYAN, V. M., "Order of Labor's Red Banner" All-Union Scientific Research Institute of Current Sources; Armenian Department, Yerevan State University

[Abstract] Photoelectrochemical conversion at a semiconductor-electrolyte interface is a promising economical method of solar energy conversion, especially when conversion to electric energy can be effected directly without consumption of electrolyte and electrode material. Insolubility of the photoelectrode material in the electrolyte is a requirement which CdS and CdSe semiconductor compounds in redox electrolytes satisfy to a large extent. Thin-film electrodes of polycrystalline CdSe are produced by anodization of metallic cadmium in CdSe solution, a redox electrolyte containing sulfide-polysulfide, or by hot molding. For an experimental study of such CdSe photoanodes, polycrystalline CdSe layers were deposited chemically on cadmium substrate after the latter had been precleaned and degreased by an aqueous solution of 5 M NaOH + 0.01 M Na_2Se at a temperature near the boiling point of cadmium. The spectral sensitivity of photoelectrochemical converters with these electrodes was determined through measurement of their current-voltage characteristics under illumination by light of various wavelengths but always the same intensity. A high-pressure xenon lamp with a monochromator served as light source. An evaluation of the data has yielded an open-circuit voltage of 0.388 V and a short-circuit current of 6.5 mA/cm^2 under a solar radiation power of 80 mW/cm^2, with the form factor remaining 0.6 throughout the range and the conversion efficiency reaching 1.8% at the peak. As the incident radiation power increases, the open-circuit voltage increases logarithmically and the short-circuit current increases first slowly (up to 5 mW/cm^2) and then fast (above 6 mW/cm^2). Most efficient converters were found to be those with the cadmium substrate pretreated chemically for 5-6 h near boiling, longer treatment not bringing about further improvement. The photosensitivity was found to be improved by heat treatment of the photoelectrodes resulting in suppression of the effect of various limiting factors. Figures 2, references 19: 1 Russian, 18 Western.
[165-2415]

MOBILE RESERVE ELECTRIC POWER SUPPLY BASED ON K-701 TRACTOR WITH ELECTRIC
POWER TAKEOFF SYSTEM

MOLOSNOV, N. F., candidate of technical sciences, and KURITSA, B. I.,
engineer, All-Union Scientific Research Institute of Electrification of
Agriculture

[Abstract] The article describes a mobile electric supply system based on
the K-701 tractor with power takeoff that includes: a synchronous generator
of three-phase alternating current; planetary gearing with transmission ratio
of 1.267, providing generator speed of 1500 rpm; two shafts with u-joints
that join the gearing to the generator and direct transmission of the
tractor engine shaft; control panel with instrumentation, electric safety
system and signaling; power and control cables; a terminal board for con-
necting up to electric power users. A GSS 104-4EU2 generator is used with
power of 200 kW with static excitation system, voltage rating of 400/230 V,
current of 360 A, frequency of 50 Hz, efficiency of 0.91, and power factor
of 0.8. The power supply is mounted behind the tractor. The unit is
designed for continuous duty at air temperature of +50°C and relative
humidity up to 95% when the temperature rises to +25°C. Fuel consumption
is no more than 55 kg/hr at rated tractor engine power of 195 kW. The
fuel tanks can keep the generator operating for 10-12 hours without refueling.
Figures 2.
[149-6610]

DESIGN OF NATURAL ILLUMINATION FOR BUILDINGS WITH AID OF UNIVERSAL
NOMOGRAMS

NURETDINOV, Kh. and KUCHKAROV, R. A., Tashkent Polytechnic Institute
imeni Abu Raykhan Beruni

[Abstract] Nomograms are constructed for calculation of the dynamics of
sky profile curvature, needed in the design of natural illumination for
buildings. These nomograms are universal, inasmuch as they refer to a
variable rather than fixed state. From three such nomograms, for a horizontal
surface, for a vertical surface parallel to the window and for one perpendi-
cular to the window, respectively, can be determined the corresponding geo-
metrical coefficient of natural illuminance for any set of horizontal and
vertiacl window orientation angles and value of the linear parameter charac-
terizing the sky condition. Figures 2, references 4 Russian.
[165-2415]

INDUSTRIAL TECHNOLOGY

EXCITATION OF OSCILLATIONS IN AUTOMATIC CONTROL SYSTEMS WITH PERIODIC DELAY

VOL'DEK, G. A. and SHMAKOV, V. E., Leningrad Polytechnical Institute
imeni M. I. Kalinin

[Abstract] Harmonic linearization is used to obtain the conditions under
which oscillations develop in a system with periodic delay. The periodic
delay function is represented as a Fourier series and the study is limited
to the first harmonic of the expansion. The case of first parametric
resonance is studied in which the frequency of the oscillations which
develop in the system is half the frequency with which the parameter
changes. Example of construction of excitation areas is presented.
References 4 Russian.
[166-6508]

ANALYSIS OF DISCRETE SYSTEMS WITH RANDOM CLOSURE INTERVALS

MADORSKIY, L. S., Minsk Institute of Electronics

[Abstract] This work is a continuation of an earlier work on design of
systems defined by equations of state based on their mathematical expecta-
tion. The present work contains a method for designing systems with
random closure intervals based on the second moment. As an example, the
stability of a closed pulse system is analyzed based on the transfer func-
tion in the open state. References 12: 11 Russian, 1 Western.
[166-6508]

ANALYSIS OF ACTUATING SYSTEMS OF AUTOMATED FORGING MANIPULATORS

MISHULIN, A. A., candidate of technical sciences, LYTKIN, I. N., engineer, SHPYAKHIN, N. P., candidate of technical sciences, and AGAKHI, K. A., candidate of physical and mathematical sciences

[Abstract] An examination is made of requirements for the actuating systems of automated forging manipulators from the standpoint of the capabilities of manipulator operation in an automated forging complex with programmed control. These requirements include: at least six degrees of freedom for the workpiece in the manipulator jaws; mutually opposed displacement of the manipulator truck and jaws with the workpiece as the latter is being reduced by the press hammers; capability of automatic calculation of geometric parameters of relative placement of elements of the actuating unit of the manipulator based on requirements of the technological controlling program for positioning the manipulator jaws; capability of placing elements of the manipulator actuating unit in the required position relative to one another; protecting elements of mechanisms from overloads that may arise during forging of the workpiece; high dynamic characteristics, It is shown that it is possible to automate solution of the inverse and direct problem of mechanism position for complex three-dimensional mechanism such as the actuating units of present-day forging manipulators. Programs are worked out for solving the direct and inverse problems on a YeS-1022 computer in FORTRAN-IV. A method is proposed for checking correct placement of position sensors from the standpoint of ensuring the required exact positioning of manipulator jaws in the automatic control mode. A principle is described for determining generalized coordinates of a mechanism comprising a stationary press block and forging manipulator jaws with seven degrees of mobility. Figures 4, references 2 Russian.
[147-6610]

TURBINE AND ENGINE DESIGN

INFLOW OF STEAM FROM END SEALS TO TURBINE BLADES

ORLIK, V. G., candidate of technical sciences, and MIKHAYLOV, S. Ya.,
NOVIKOV, B. B. and REZNIK, L. B., engineers

[Abstract] Moisture in the end seals of a low-pressure cylinder is fed in the
form of steam to the turbine in all its operating modes and enters the root
zone of the impeller, where back currents occur which can carry the moisture
along to the outlet edges of the blades. This fact is a probable cause of
erosion of these edges. Experiments were conducted in which thermocouples
were installed in liners which the steam leaving the seals flows around, and
in the gap between the impeller disk of the last, 34th, stage and the firebox,
at four points along the periphery. Thermocouples were also installed on the
firebox metal and on the pipelines of the seals, as well as on the flange and
pipelines of the end seals behind the 29th stage. The moisture running off
was collected in traps and funnels and was sent through a pipe to a graduated
container for measurement. The tests demonstrated that superheated steam
enters the exhaust nozzle from the end seals. The steam from the seals con-
denses in fireboxes. Steam from the seals condenses on the inside walls of
the chambers of the end seals of the low-pressure cylinder because of good
thermal contact between the casings of the seals and the cylinder, and this
condensation requires drainage. Automatic drainage can be provided with the
proper pitch of pipes when the seals' steam is fed to the bottoms of fire-
boxes. It is necessary to provide drain pipes for areas in which natural
drainage does not take place. It is emphasized, however, that the amount
of moisture formed in the compartments of seals is one of two orders of
magnitude lower than that originating from other sources, and that end seals
cannot be considered one of the main sources of erosion of the outlet edges
of the blades of final stages of a turbine. Figures 2, references 3 Russian.
[120-8831]

EFFECTIVENESS OF USE OF SHAPED TWISTED TUBES IN HEAT EXCHANGERS OF TURBINE
PLANTS

BRODOV, Yu. M., candidate of technical sciences, Ural Polytechnical
Institute

[Abstract] An analysis is made and the results are generalized of laboratory
studies, industrial tests and know-how gained in the use of heat exchangers
with shaped twisted tubes in turbine plants. The use of such tubes is one
way of improving the efficiency of heat exchangers. Data are presented on
hydrodynamic resistance, convective heat transfer in flow of a single-phase
heat-transfer medium inside a shaped twisted tube, convective heat transfer
in condensation of steam in a tube of this sort, and the dirt retention of
these tubes. Data collected by various organizations demonstrate that the
main quantity determining the hydrodynamic resistance of these tubes is the
ratio of the height of the bulge to the distance between neighboring bulges,
h/S. The influence of other factors proved to be insignificant. Convective
heat transfer with the flow through these tubes of water and air differs
considerably. This is due to the fact that the boundary layer functions
differently. With water, convective heat transfer depends more substantially
on flow conditions, but there is practically no such dependence with air.
In the case of water, the intensity of convective heat transfer depends on
the geometrical parameters of the tube, i.e., h/S and the inside diameter
of the tube, and on water flow conditions. For both water and air the
relative convective heat transfer coefficient is lowered with an increase in
the Reynolds number. Experimental data from various authors are analyzed,
relating to the effect of the intensification of convective heat transfer
with condensation of steam in a shaped twisted tube. Further studies are
required in this direction, but it is believed that the intensification
effect is associated with the different heat exchange surface in these
tubes as compared with smooth tubes, independently of their geometry. The
surface of the majority of shaped twisted tubes is up to 8-percent smaller
than that of corresponding smooth tubes. The process of scale formation
is 1.5-fold more intense in smooth tubes than in shaped twisted tubes.
This is believed to be associated with the fact that secondary flows are
created by the spiral bulges. The tubes discussed have somewhat greater
dirt retention than smooth tubes, but they maintain relatively greater
effectiveness in spite of this. No contraindications have been found for
the use of shaped twisted tubes for water of various compositions and
various dirt contents. The reliability of heat exchangers using these
tubes is not inferior to that of heat exchangers employing smooth tubes.
The useful life of these tubes is not substantially reduced by the 10- to
15-percent increased corrosion wear of the bulges as compared with smooth
tubes. The convective heat transfer coefficient is increased anywhere
from 20 to 70 percent when using heat exchangers with shaped twisted tubes,
as compared with smooth tubes. Figures 2, references 19: 18 Russian,
1 Western.
[120-8831]

VERIFYING ANALYSIS OF MULTISTAGE STEAM TURBINES

SIROTKIN, Ya. A., candidate of physical and mathematical sciences, school for advanced technical training plant, Leningrad Metal Plant POT [expansion unknown]

[Abstract] A unidimensional stage-by-stage verifying aerodynamic analysis is discussed for a multistage axial-flow turbine operating on superheated steam at subsonic velocities. The technique employed is an intermediate one between the traditional unidimensional verifying analysis and analysis in terms of rim clearances, taking into account the slope and curvature of meridian stream-lines. The analysis is performed by taking into account integral equations of balance not only for flowrate and energy, but also for entropy and angular momentum relative to the axis of rotation. A verifying analysis is necessary for the purpose of estimating the effectiveness of a newly designed setting and for analysis of various operating modes. The analysis is based on a model of two-dimensional axisymmetric flow in a stage. The transition from the inlet edge of the nozzle rim to the throat and from it to the outlet edge and then to the inlet edge of the blade rim, etc., is made with reference to the mean diameter. The equation of radial equilibrium along the edges of the rims is integrated and an analysis is made of rearrangement of the flow in rim clearances because of overlapping and meridian expansion of these clearances, taking into account the condition $c_u r$ = const along stream-lines, the balance of leaks, suction and inflow and their mixing with the main flow in the outlet of the rims. A stage is analyzed in terms of seven sections--the inlet and outlet edges and the throat of each rim and the inlet to the next stage, to the bypass channel or to the diffuser of the discharge nozzle. From the flowrate, pressure, temperature and inleakage angles for the flow predetermined in the stage's inlet, and from leakage under the closure, the velocity and deceleration parameters are found, after which the radial equilibrium equation is integrated by the Runge-Kutta method from the mean diameter to the root and periphery along the inlet edge of the rim. Then a determination is made of the critical flowrate for the rim's throat. If the flowrate in the stage's inlet minus the leakage under the closure is less than or equal to the critical flowrate for the rim's throat, an analysis is made of the outlet edge with integration of the radial equilibrium equation, and a computation is made of $(c_u r)_2$ = f(r). Examples are given of analyses performed on a YeS-1022 computer, of typical stages, sections and high- and medium-pressure cylinders of high-power steam turbines at the Leningrad Metal Plant. Figures 5, references 13 Russian.
[120-8831]

TURBINE MACHINE LABYRINTH SEAL GEOMETRIC PARAMETER OPTIMIZATION

ZHARKOY, M. S., engineer, Alma-Ata Power Engineering Institute

[Abstract] Optimization of the spacing of labyrinth seal elements solely on the basis of labyrinth chamber aerodynamic quality as is done at present is not sufficient, since the spacing has a double influence on the flow of working fluid through the labyrinth, both by increasing the length of the flat jet along the bottom of the labyrinth chamber, and also by decreasing the number of seal elements which increases flow. Calculation equations are derived for optimization for typical straight flow and stepped labyrinth seals. Figures 3, references 7 Russian.
[163-6508]

PLANNING OF TURBINE STAGES WITH TANGENTIAL SLOPE OF VARIABLE PROFILE GUIDE VANES

AFANAS'EVA, N. N., candidate of technical sciences, and PERTSOVSKIY, L. S., student, Leningrad Order of Lenin Polytechnical Institute imeni M. I. Kalinin

[Abstract] Variable profile guide vanes can be planned as follows: use the calculated angle of the guide vane tangential slope to find the radial component of mass force of the blades' action on the flow, assuring the assigned difference in peripheral and root reactions; assigning a guide vane surface slope angle, determine the value of force as the integral mean in the channel between vanes; construct the variation of force as a function of slope angle and find the guide vane tangential slope which provides the design value of radial vane force component. This article analyzes determination of the mean integral radial vane force component in the channel between vanes, assuming the flow to be axisymmetrical. A graph compares reaction in a stage on the basis of calculated and experimental values. Figures 3, references 3 Russian.
[163-6508]

THERMALLY STRESSED STATE OF PT-135/165-130/15 TURBINE ROTOR DURING STARTUP

POKHORILER, V. L., candidate of technical sciences, PASHNIN, V. M.,
GALIMULIN, N. N. and MARKOVSKIY, V. M., engineers, Urals Polytechnical
Institute, Uraltekhenergo

[Abstract] Thermodynamic analysis was used as a basis to select the
system for determining the hot steam temperature in calculating the tempera-
ture field in a turbine rotor. Experimental data obtained at Uraltekhenergo
in determining the optimal startup conditions of the turbine at the Volga
and Novo-Salavat heat and electric powerplants were used in the analysis.
Data from 14 startups at various initial turbine thermal states ranging from
cold to hot were used. It was found that when the PT-135-130 turbine operates
in the base line mode the appearance of cracks in the rotor is not a genuine
danger throughout the entire period of operation. When this turbine or other
heat supply turbine with the same high pressure rotor, such as the T-175-130,
R-100-130, is used to regulate the load schedule of a power system, it may
be necessary to decrease elastic stresses in the rotor in order to increase
the permissible number of startup and shutdown or load change cycles. One
method of improving this startup technology is to eliminate cooling of the
rotor during spinup of the turbine as the speed regulator begins operation.
Figures 5, references 8 Russian.
[164-6508]

STUDY OF AXIAL FORCES IN K-500-240-2 TURBINE

SEREZHINA, L. P., candidate of technical sciences, PANFILOVA, A. I.,
engineer, and ZARETSKIY, Ye. I., candidate of technical sciences, All-Union
Heat Engineering Institute, Khar'kov Turbine Plant

[Abstract] During planning of the K-500-240-2 turbine, the principle of
balancing forces in each cylinder was used as a basis. The forces created
by steam flow on disks and vanes in each rotor are primarily balanced by
forces created on the steps of the same rotor. The turbine consists of
4 cylinders: high pressure, medium pressure and two two-path symmetrical
low pressure cylinders. Steam at 540°C, 23.6 MPa enters the high pressure
cylinder, then at 3.9 MPa enters the intermediate steam superheaters and
thence the medium pressure cylinder. The load on the axial bearing was
measured by resistance strain gages glued to elastically deformable elements.
Balancing of the high pressure rotor was so successful that the maximum
load on bearings in rapidly transient operating modes is not significantly

different from the nominal power mode. The bearing can be used in all turbine operating modes. This indicates that the method of balancing forces in each cylinder is preferable. Figures 4.
[164-6508]

DEVELOPMENT OF STAGES FOR HIGH TEMPERATURE GAS TURBINES

KIRILLOV, I. I., doctor of technical sciences, AGAFONOV, B. N., AFANAS'EVA, N. N., KIRILLOV, A. I., PROSKURYASKOV, G. V., CHERNIKOV, V. A., candidates of technical sciences, and SHVARTSMAN, O. A., engineer, Leningrad Polytechnical Institute Planning Department, Tomsk Metals Plant

[Abstract] The turbine building problems laboratory of Leningrad Polytechnical Institute in cooperation with the Urals Turbine Motor Plant has been systematically studying the characteristics of highly loaded stages in both single stage and two stage turbines. Five model stages have been studied at the Institute. The summary characteristics in stages 1 and 2 of these models have been studied over a broad range of characteristics and operation conditions. The main reason for high energy losses in the drive wheel in some turbines is the great angle at which the flow is rotated in passing through the wheel in combination with the high velocities and relative step in the peripheral cross section. The results of testing of stages 3 through 5 have indicated that efficiency is much higher in stage 3 than in stages 1 and 2. The highest efficiency is that of stages 4 and 5. It is quite realistic to design large circulation stages with efficiencies of 89%. Figures 5, references 4: 3 Russian, 1 Western.
[152-6508]

POWER GAS TURBINE COMPRESSOR CHARACTERISTICS

MEKHANIKOV, A. I., engineer, OL'KHOVSKIY, G. G., doctor of technical sciences, and OL'KHOVASAYA, N. I., engineer, National Institute of Heat Engineering

[Abstract] Eighteen types of axial compressors with compression ratios of 2 to 7 and throughputs of 5 to 360 cubic meters perssecond were studied. The primary characteristics are presented in a table. The low efficiencies found in some compressors resulted from selection of poorly suited initial stages and improper profiling of the flow-carrying portion of the compressor. Sometimes good calculated characteristics were not achieved in practice due to an increase in the radial gaps in the flow-carrying portion and warping of stator parts of poor centering, making stable operation impossible.

Some problems which developed during startup of the ini ial models of some turbines are discussed. Figures 6, references 17: 15 Russian, 2 Western. [152-6508]

STUDY OF COOLED CHANNEL VANES IN HIGH POWER GAS TURBINES

ARSEN'EV, L. V., doctor of technical sciences, KOVALEV, A. N. and MITRYAYEV, I. B., candidates of technical sciences, Leningrad Metals Plant, Leningrad Polytechnical Institute

[Abstract] Results are reported from a mathematical study of the temperature profiles in gas turbine vanes cooled by holes drilled through the vanes from root to tip in one or two rows, with one larger hole at the entry cross section. The studies indicate that the cooling effectiveness can be significantly increased by internal heat exchange intensification at the intake edge by the use of special flow-smoothing inserts in the channel. Diagrams of insert shapes and resultant efficiency increases are presented. Figures 5, references 4 Russian. [152-6508]

LIMITING CONDITIONS OF EROSIVE DAMAGE TO TURBINE VANE TRAILING EDGES IN HIGH POWER STEAM TURBINES

OGURTSOV, A. P., engineer, KHRABROV, P. V., candidate of technical sciences, PAKHOMOV, V. A., engineer, KHAIMOV, V. A., candidate of technical sciences, and MYAKAS, V. I., engineer, Leningrad Metal Plant, Central Scientific Research, Planning and Design Boiler and Turbine Institute imeni I. I. Polzunov, Lithuanian Regional Electric Powerplant

[Abstract] This study was based on examination of a large number of damaged steam turbine vanes. Based on studies of the flow mixtures of steam and water droplets through the channels between vanes and erosive impact of water droplets with vanes, a design is developed for steam receivers to minimize vane erosion. The receiver provides for flow of the boundary layer of liquid developing upon excessive condensate input to the steam cooler outward at the intake section of the nozzle into a drain line through a separate pipe and into the lower portion of the condenser. Use of the new receiver will assure maximum droplet diameter at the core of the flow of not over 12 μm, in the wake downstream from the atomizer not over

36 μm for a condensate temperature of 30°C, 7 and 25 μm for condensate temperature 140°C. Figures 3, references 8 Russian.
[152-6508]

INFLUENCE OF FLOW ROTATION ON AXIAL FORCE ON TURBINE WHEEL

BAYBIKOV, A. S., doctor of technical sciences and LISICHKIN, G. M., engineer

[Abstract] An earlier work presented a method for calculating the flow of fluid in the cavity between the body of a turbine and the disk of its drive wheel with a seal at the outside diameter with radial leakage of the drive fluid toward the periphery. This article presents calculations for a wheel operating without a seal. The rapid flow of working fluid between the wheel and the body causes a significant redistribution of pressure around the radius of the cavity and a corresponding change in axial force, and may lead to nonuniform heating and deformation of the disk. The greater the gap open around the periphery of the cavity the more intensively energy is transferred from the external flow to the flow in the cavity, increasing the pressure gradient over the radius of the disk. A figure illustrates the influence of radial working fluid flow rate from the axis toward the periphery on the static pressure curve. The method for calculating the hydrodynamics of flow in the cavity around the rotating disk of a turbine considers the effect of flow with a circumferential velocity component greater than the speed of the disk and allows estimating G_{min} through the cavity. Figures 4, references 4 Russian.
[153-6508]

CALCULATION ESTIMATE OF STRESS STATE AND CYCLICAL STRENGTH OF K-300-240 KhTGZ TURBINE LOW AND HIGH PRESSURE STAGES

BERLYAND, V. I., candidate of technical sciences, POZHIDAYEV, A. V., engineer, PALEY, V. A., candidate of technical sciences, and LEVIT, I. G., engineer, Central Design Office of Glavenergoremont, Kharkov Turbine Plant Production Association

[Abstract] Results are presented from mathematical studies of the stress-strain state and cyclical strength of K-300-240 and K-300-240-2 turbine low

and high pressure stages. A table presents the calculated stress-strain
states. The use of a two stage low pressure section can decrease thermal
stresses by a factor of 1.5 to 2 and thus increase the permissible number
of loading cycles by a factor of 4 to 10. The maximum thermal stresses
do not prevent an increase in operating life above the design life of
100,000 hours if the condition of the metal is tested and defective parts
eliminated. Experimental studies are required to determine true operating
lives. Figures 5, references 12 Russian.
[153-6508]

EXTENDED TESTS OF GAS TURBINE PLANT ON 'KAPITAN SMIRNOV' SHIP

GARTVIG, V. V., LITAVRIN, O. G. and PLISKIN, G. M.

[Abstract] The main gas turbine engine driving two propellers (nominal
power 14,120 kW, maximum power 18,390 kW) on board of the "Kapitan Smirnov"
high-speed vessel operates in two modes, "at sea" with the steam-type heat
economizer on and "in port" with that economizer off. Since its recent
installation, tests have been extended so as to cover the many new instru-
ments and special equipment. The basic characteristics of this power plant
were measured at an ambient temperature of 288 K and include effective power
as function of high-pressure compressor speed (nominal speed 7840 rpm) and
economy with grade TG fuel containing 0.6% vanadium, above maximum per-
missible level, and therefore mixed with grade DS diesel fuel in the 1:1.425
ratio. Also measured were the reverse-drive characteristics in a backward-
forward cycle of 100 s duration and in a forward-backward cycle of 84 s
duration, the heat economizer starting and running characteristcs, and
characteristics of the ejection-type cooling system for turbine and economizer
boiler; pressure of superheated steam as function of steam rate and air rate
as function of gas pressure head. The test data, obtained and processed
with an automated measuring-computing complex, confirm the high performance
of this plant and serve as basis for further design and performance
improvements. Figures 8, references 3 Russian.
[110-2415]

TEMPERATURE FIELDS OF TURBOGENERATOR ROTOR WITH SUPERCONDUCTOR FIELD WINDING

GLEBOV, I. A., DANILEVICH, Ya. B., BELYAYEV, S. N., BRYNSKIY, Ye. A.,
ZHURAVLEV, G. S., KARCHOV, D. S., SMOLIN, I. M., SOLOVEYCHIK, Yu. G.
and SHURINA, E. P.

[Abstract] A turbogenerator rotor with superconductor field winding is, for
the purpose of analysis, regarded as a rotating cryostat. On this basis,
the temperature fields of such a rotor are calculated for a structure con-
sisting of the field coil and a banding ring which prevents rupture of the
coil by centrifugal forces and ties it mechanically to the flanges on the
shaft. Modern superconductor materials require cooling to 5-10 K, which is
attainable with helium. The corresponding nonlinear differential equation
is solved for the various regions of the rotor, with three kinds of boundary
conditions: ideal thermal contact between regions, nonideal thermal contact
between them, and radiative heat transfer at their boundaries. This system
contains nonlinearities of the first kind and of the second kind. Considera-
tion is taken of the temperature dependence of the thermal conductivity of
copper and steel, described by empirical relations. The problem is solved
first by iteration, for determining the thermal conductivity and approximating
it with a piecewise-constant function, then by linearization in its Laplace-
operator form in cylindrical coordinates, and minimization of the correspond-
ing quadratic functional by variational-difference approximation with each
rotor region subdivided into a grid of rectangular elements matching at the
boundaries. The temperature field has been computed by this method for the
rotor of a KTT 20 MW - 3000 rpm cryoturbogenerator in the steady state,
the accuracy depending on the stipulated magnitude of thermal unbalance
fluxes. Figures 2, references 4 Russian.
[154-2415]

METHOD OF DESIGNING LONG TURBINE BLADES

GOGOLEV, I. G. and KUZ'MICHEV, R. V., Bryansk

[Abstract] A most effective and also simple method of designing relatively
long blades for axial turbines is described, the main objective being to
optimize the twist and to correct the profile of the inlet edge. First
the twist of the stream is calculated according to a theoretical law,
usually $rc_u^n = $ const (r- radius of blade cross section, c_u- component of

absolute velocity of the stream in the direction of the tangential velocity
of the runner). Then corrections are added on the basis of generalized
experimental data on the radial profiles of stream parameters: reactivity and
entrance angle. An evaluation of available data has revealed that the dis-
crepancy between theoretical and experimental values of these stream parameters
is not appreciable, regardless of the law according to which the twist has
been calculated. Two simple empirical relations are proposed, therefore, one
for each parameter as a function of the length-to-diameter ratio. The
method was tested and its expediency demonstrated on the design of two models
of axial turbine stages: one with the runner blades twisted according to the
law rc_u = const (n = 1) and one with the inlet edge of the blade profile
corrected over the entire blade length. The guide vanes were the same for
both models. Both models were tested at subsonic speed (Mach number M = 0.3)
in an air stream entering uniformly through the guide passages and exiting
into the atmosphere. All parameters determining the integral performance
characteristics were measured. The stream was probed, before entrance to and
behind exit from the runner, under conditions of the optimum u_m/C_0 ratio
(u_m-tangential velocity of runner at median diameter of stage, $C_0 = \sqrt{2h_0}$ -
fictitious reference velocity, h_0- isentropic enthalpy drop across stage).
The characteristics of blades designed by this method were found to be
better than those of blades designed with a theoretical twist: smaller
radial reactivity gradient and smaller twist, resulting in a lower manufactur-
ing cost and in more economical operation. Such a design will ensure shock-
less streamlining at subsonic speed, will also make it feasible to reduce the
number of stages and thus the overall size of a turbine. Figures 3, table 1,
references 7 Russian.
[155A-2415]

EXTREME NOISE OF OPERATION OF AXIO-RADIAL TURBINE STAGES

KIRILLOV, I. I., BIRZHAKOV, M. B., LITINETSKIY, V. V. and BERMAN, B. I.,
Leningrad

[Abstract] The behavior of centrifugal axio-radial stages of steam
turbines in extreme modes of operation is analyzed from the design standpoint,
as basis for improving the performance under conditions widely deviating
from nominal ones under full load. Theoretical relations for steam rate
and power in an isentropic process are modified by introduction of empirical
coefficients accounting for the effect of nozzle and runner geometry on the
performance. The expressions for these coefficients as functions of geo-
metrical and process parameters are converted to approximating second-degree
polynomials of the $C = a\bar{x}^2 + b\bar{x} + c$ kind, with numerical values of a,b,c
based on experimental data obtained by testing four turbine stages

(K-300, K-500, K-800, K-1200) at the Leningrad Polytechnic Institute and the dimensionless variable

$$\bar{x} = (\frac{u}{c_0}1)/(\frac{u}{c_0}1)_{extr} \quad (u_1 - \text{tangential velocity of runner}),$$

for a turbine running as generator and as compressor respectively. A third coefficient is added, this one characterizing the change of steam temperature in the runner during load changes and transitions from one mode of operation to another. The generalized data were used for a more economical design of the low-pressure cylinder in such turbines and for calculating its performance in very inefficient modes of operation such as blow-off, without steam, and motoring. The data can also be used for analyzing the dynamics of turbine operation following a smooth decrease of the steam rate to zero, with the medium-pressure cylinder and then the high-pressure cylinder also gradually passing into the blow-off mode. Figures 5, table 1, references 9: 6 Russian, 3 Western.
[155A-2415]

DIFFUSERS OF CENTRIFUGAL COMPRESSORS WITH TWO ROWS OF ASYMMETRICALLY SPACED BLADES

ANISIMOV, S. A. [deceased], candidate of technical sciences, docent, ROSSEL', V. V., engineer, and SHERSTYUKOV, V. A., candidate of technical sciences, "Order of Lenin" Leningrad Polytechnic Institute imeni M. I. Kalinin

[Abstract] A theoretical and experimental study of two-row blade-type diffusers of centrifugal compressors was made, for the purpose of determining the effect of blade spacing patterns on the gas dynamics and on the performance of such a compressor stage. Asymmetric spacing of blades was considered, symmetric spacing of the short blades not necessarily being most expedient. The local velocity along the profile, normalized to the entrance velocity, was calculated and measured as function of the distance on the circumference. The results obtained for various angles of attack in two most typical asymmetric blading arrangements, namely $d/t = 0.25$ and 0.625 respectively (d - distance on the circumference from a long blade to a short blade in the direction of runner rotation, t - circumferential pitch of long blades), reveal that shifting the short blades in the direction of runner rotation widens the range of economic and efficient operation, especially at gas flow rates above optimum. Shifting the short blades in the other direction has the opposite effect. On the basis of these results, there exists and has been determined the optimum position of the short blades relative to the long ones. Figures 2, table 1, references 6 Russian.
[156-2415]

OPTIMIZATION OF BASIC PARAMETERS OF AES WITH STEAM TURBINES AND GAS-COOLED
FAST REACTOR TAKING INTO ACCOUNT CONSTRAINTS ON GAS BLOWING POWER

LARIN, Ye. A., candidate of technical sciences, ONISHCHENKO, V. Ya.,
candidate of technical sciences, and SEMIN, A. G., engineer, "Order of
Labor's Red Banner" Saratov PolytechnicaInstitute

[Abstract] In atomic electric power plants with steam turbines and gas-
cooled fast reactor an appreciable fraction of generated electric power
(6-10%) is needed for blowing the gaseous coolant through the first loop.
Raising the temperature of the feed water will increase the plant efficiency
and the developed electric power, but will also require more electric power
for driving the gas blowers. The problem of optimizing an AES parameter
under these constraints, with minimum normalized total cost or its variable
component as optimality criterion and with an upper limit on the cost of
gas blowers, reduces to a partial differential equation with a Lagrange
multiplier. The optimum values of parameters can be determined so as to
satisfy the Kuhn-Tucker necessary and sufficient conditions. The algorithm
of such an optimization has been applied to the temperature of the feed
water and the pressure of the super-heated steam in a fast reactor generating
4,300 MW of thermal power, with helium cooling (helium entering at 260°C
and leaving at 620°C), for initial steam at 17.0 MPa and 540/540°C.
Figures 3, references 2 Russian.
[156-2415]

BEHAVIOR OF LOW-PRESSURE COMPONENT OF DISTRICT HEATING TURBINES DURING
OPERATION WITH MINIMUM STEAM ADMISSION TO CONDENSER

LEONKOV, A. M., professor, and BALABANOVICH, V. K., "Order of Labor's
Red Banner" Belorussian Polytechnic Institute

[Abstract] The factor which limits turbine operation in modern heat and
electric power plants running with fossil fuel is the reliability of the
low-pressure component under conditions of minimum steam admission to the
condenser for blow-off and heating of makeup water. The reliability of the
last stage is lowered principally by a vortex appearing in the root zones
with nonuniform and nonsteady distributions of flow parameters. Such a
vortex causes not only vibration of blades, including resonance modes, but
also erosion of their exit edges by moisture it carries from the condenser.

Experimental studies on T-100-130 and PT-60-130/13 turbines, with measurement of the temperature field before and in the last stage, have revealed that the present cooling system with injection and spray of condensate into the steam exhaust tube is inadequate. An improvement in the form of an expander of spperheated water is proposed, for generating saturated or high-quality steam and to be connected to the cooled main turbine channel. The feasibility and effectiveness of this device have been demonstrated on an experimental air turbine including a last stage with large fan-out. While the operation of such a stage at extremely low steam rates or without steam has not yet been fully explored, it is already known that the negative pressure drop will increase with increasing drag in the turbine entrance zone and that the power drawn (negative power) will decrease with increasing u/C$_0$ ratio (u- tangential velocity of runner). This corresponds to operation of the low-pressure component with rotatable baffle closed. Figures 3, references 6 Russian.
[156-2415]

VORTEX STRUCTURES AND MOVEMENT OF MOISTURE THROUGH TURBINE

KIRILLOV, I. I., doctor of technical sciences, professor, meritorious scientist and technical worker of the RSFSR, recipient of USSR state prizes, and SHPENZER, G. G., candidate of technical sciences, docent, "Order of Lenin" Leningrad Polytechnic Institute imeni M. I. Kalinin

[Abstract] In order to design turbine stages with large fan-out for reliable operation under partial loads, at low steam rates, it is necessary to analyze their performance over the entire load range with proper consideration of vortex structures and movement of moisture in the flowthrough channels. Experimental studies have been made at the Leningrad Polytechnic Institute as well as at the Moscow Institute of Power Engineering and the Central Institute of Turbines and Boilers imeni I. I. Polzunov. Here the experimental data are interpreted theoretically, on the basis of fundamental equations of motion for a liquid drop in vapor and for a vortex in wet steam. Only the aerodynamic force on a liquid drop and the force holding it at the center of a vortex are taken into account, all other forces being disregarded as negligible in comparison. The conditions for suspension are established, and all realtions are combined for determining the mode of moisture transport by a vortex. The effect of a moisture-carrying vortex structure on flow separation is considered in an evaluation of the characteristics of the last turbine stage, where this effect becomes most appreciable, especially near the periphery. Figure 1, references 9 Russian.
[156-2415]

RELATION BETWEEN AERODYNAMICS IN COMBUSTION CHAMBER AND DYNAMICS OF
HEAT RELEASE

DUDKIN, V. T., DUDIN, L. A. and KOSTERIN, V. A.

[Abstract] Operation of aircraft gas-turbine engines with higher gas
temperatures and lower toxic emission levels requires improvement of fuel
mixing and combustion processes. An experime tal study was made of circu-
lation zones, hydraulic drag, and heat release dynamics in a cylindrical
combustion chamber 150 mm in diameter with barriers of various shapes
(disk, cone, cylinder) and sizes (40, 60, 80, 96, 112 mm in diameter) on the
axis, for the purpose of establishing the dependence of these performance
indicators on the system geometry. The study involved measurement of the
aerodynamic characteristics of the trails behind the barriers and of the
degree of combustion completeness. The results are interpreted in terms
of hydrodynamic and thermodynamic relations, taking into account turbulence
and including the dependence of certain quantities on physico-chemical
properties of the fuel mixture (kerosene-air) as well as on combustion
chamber and flame stabilizer geometry. Approximate expressions derived
on this basis can serve as a tool for combustion chamber design and
optimization. Figures 3, references 5: 4 Russian, 1 Western.
[150-2415]

LOSS OF TOTAL PRESSURE IN DIFFUSERS IN MIXING-AFTERBURNING CHAMBERS

DANTSYG, A. Ya. and PETROV, N. M.

[Abstract] A two-stage turbojet engine with common mixing-afterburning
diffuser chamber is considered, a design parameter very difficult to cal-
culate being the loss of total pressure in the diffuser. Here this loss of
total pressure is calculated for a diffuser where mixing occurs simultaneously
with retardation of flow in both inner and outer engine stages. According
to a simplified model, the mixer chamber is subdivided into two segments,
one with uniform cross section where complete mixing takes place followed by
a diverging one where the stream of mixture decelerates. The pressure loss
in the first segment is calculated on the basis of energy and mass flow rate
conservation with observance of entropy balance. Results of calculations
according to this model have been checked against experimental data on two

annular diffusers, one with a ring mixer and one with a lobe mixer, the error of underestimation being larger in the case of a lobe mixer. The accuracy of this model can be improved by taking into account the real distributions of flow parameters, particularly of the normalized velocity, in the mixer throat section in each stage. Figures 5, references 5 Russian.
[150-2415]

EXPERIMENTAL STUDY OF ANNULAR FILM-VAPORIZATION COMBUSTION CHAMBER FOR LOW-POWER GAS-TURBINE ENGINE

AFROSIMOVA, V. N., VOLOSHIN, S. A., KAV'YAROV, V. I. and KOZEL'SKIY, Ye. I.

[Abstract] An experimental study of an annular film-vaporization combustion chamber for low-power gas-turbine engines was made, for the purpose of determining the degree of uniformity of fuel-air mixture distribution and combustion. The channel was formed by the wall of the exhaust pipe and a surrounding special thin evaporator shell, the latter heated on the ouside by flue gases. Fuel was injected through six orifices uniformly spaced around the channel, air was injected tangentially with swirling through a turbulizer. The temperature field was measured with a thermocouple on a rotating ring which also carried a gas sampler-analyzer for determining the concentrations of CO_2, O_2, CO, and hydrocarbons in the combustion products. The degree of combustion completeness calculated from the data, as function of the ratio of total orifice area to channel cross-sectional area, indicates that such a combustion chamber can operate efficiently enough for low-power gas-turbine engines with severe size limitations. Addition of an annular precombustion chamber for mixture preparation will improve the combustion process with lower hydraulic losses. Figures 2, references 4 Russian.
[150-2415]

SELECTION OF OPTIMUM OUTPUT PARAMETERS OF STARTER FOR DOUBLE-SHAFT TWO-STAGE TURBOJET ENGINE

AVGUSTINOVICH, V. G., ALEKSEYEV, V. V. and TRUBNIKOV, Yu. A.

[Abstract] Optimization of a starter for a double-shaft two-stage turbojet engine is described which yields maximum starter power and transfer

ratio from starter turbine shaft to high-pressure runner shaft with maximum reliability and minimum weight. Calculations are based on a mathematical model of the starting process and involve numerical integration of the corresponding first-order differential equation of motion for the high-pressure runner on a digital computer. For characterization of the high-pressure stage, the ratio of developed turbine power to required compressor power as a function of the turbine runner speed has been determined from experimental data on runner speed and starter power. The power-speed characteristic of the starter has then been calculated along with the minimum ratio of turbine power to compressor power as a function of the ratio of starter power to compressor power and of starter operating time. The characteristics cover a range between the "rich fuel" limit and the "lean fuel" limit. As the starter power is increased, the starting band within this range widens toward the "lean fuel" limit and starting thus becomes more reliable. Lengthening the starter operating time by 20% is approximately equivalent to reducing its required output power by 10%, without loss of reliability. The optimum transfer ratio increases linearly with increasing starter power, up to a certain level of starter power beyond which it remains constant. Figures 3, references 1 Russian.
[150-2415]

DETERMINATION OF RANGE OF EXPEDIENT APPLICATION FOR MICROTURBINES WITH REENTRY OF WORKING MEDIUM

TIKHONOV, N. T. and MATVEYEV, V. N.

[Abstract] Use of multistage microturbines as high-speed aircraft engines is expedient only when the exit losses and the losses due to partiality of feed can be simultaneously reduced. This is possible if the working medium is reentered into the runner blading. The range of expedient application for such a microturbine is best established on the basis of a comparative performance analysis with a single-stage axial microturbine as reference. Calculation of the gasdynamic characteristics of both reveals that a microturbine with reentry is more efficient than a single-stage axial one at low relative tangential runner velocities, the advantage increasing with decreasing velocity, and that the effectiveness of reentry is largely determined by the degree of gasdynamic ideality of the reentry channel. In a microturbine of typical diameter size it is possible to effect reentry within a narrow range of variation of nozzle partiality so that the latter will not significantly effect the engine economy. Figures 3, references 8 Russian.
[150-2415]

SET OF CRITERIA FOR ENGINE INTERFACING AND EFFICIENCY ESTIMATION IN
PRELIMINARY STAGE OF TECHNICAL EVALUATION

SGILEVSKIY, V. A.

[Abstract] The problem of engine matching to aircraft and engine efficiency
estimation in the preliminary technical evaluation stage is solved by means
of criterial and dimensional parametric analysis, for the most difficult
case of a multitarget aircraft. The load parameter and the interfacing
parameter (introduced by I. F. Florov) are the two basic essential ones,
both related to the flight program and the engine performance through
equations of motion and coupling. From the ratio of these two parameters
as well as from the relations between quantities included in their complexes
and from their dependence on other system variables there is derived an
entire set of criteria and characteristics necessary for flight simulation
and engine regulation in the preliminary technical evaluation by an auto-
matic design system. Figure 1, references 2 Russian.
[150-2415]

MATHEMATICAL MODEL FOR UPPER-LEVEL AUTOMATIC DESIGN OF HELICOPTER GAS-
TURBINE ENGINE WITH OPTIMUM REGULATION PROGRAM

NAUMOV, A. V.

[Abstract] A mathematical model is constructed for upper-level automatic
design of a helicopter gas-turbine engine matching a helicopter flight
program. It is adapted from an existing design program for a turbofan with
free turbine and regulation of three parameters. The problem of determin-
ing the engine parameters during steady-state periods in an optimum regula-
tion program is reduced to a problem of nonlinear $F(X)$ under constraints
on the variables X and on arbitrary functions $Q(X)$. The minimization
algorithm is based on the method of sliding tolerance, adapted for this
particular application. It is executed in the interactive mode with alpha-
numeric display and correction of input data, on an M4030 computer with disk
operating system and added modules for any other than turbofan type of
engine. Figures 1, references 5 Russian.
[150-2415]

TRANSIENT PROCESSES OF COMBUSTION SURFACE FORMATION IN SOLID-PROPELLANT
ROCKET ENGINE WITH HYDRAULIC REGULATOR

KRIVOSHEYEV, I. A., LIKHOVSKIY, V. A. and SHAYKHUTDINOV, Z. G.

[Abstract] A solid-propellant rocket engine with wide hydraulic regulation
of the combustion surface is considered, where the charge infiltrates through
channels filled with a fluid which it expels into the atmosphere through a
special valve. Propagation of the combustion front and formation of the
combustion surface along such a channel are analyzed on the basis of a model
which includes nonlinearities in the system, heating and evaporation, relaxa-
tion of the temperature profile and time delay of ignition, all depending
on fuel characteristics, channel dimensions, and combustion rate. All the
many possible channel configurations can be reduced to equivalent combina-
tions of any three types: 1) axisymmetric single-channel type regulation
inside and cladding of the outside lateral surface; 2) the same with
regulation outside and cladding of the inside surface; 3) flat channel
with regulation along one side and cladding on all other sides. The
algorithm of calculations is constructed accordingly, for programming in
FORTRAN-4 and execution on YeS computers, using the superposition principle
for evaluation of the transient processes involved in reshaping the com-
bustion surface during regulation. Figures 4, references 6 Russian.
[150-2415]

METHOD OF CALCULATING PARAMETERS OF TURBOJET ENGINE FOR WINDMILLING MODE
OF OPERATION

KUZNETSOV, V. I.

[Abstract] Design of a turbojet engine for windmilling is considered,
this mode of operarion being characterized by no heating of the gas in the
combustion chamber. The conventional method of calculating the engine
parameters for operation in this or steady-state modes requires data on
engine and compressor characteristics at low speed as well as on transient
processes in intake device, combustion chamber, and jet nozzle. Here a
simpler method is proposed, on the assumption that the energy of the in-
coming air stream is expended only on overcoming drag in the gasdynamic
channel and useful work. On this basis are calculated: specific work of

the air stream, air temperature at the compressor entrance, compression ratio, work of the compression process, and work of the compressor drive (turbine) – all as functions of thermogasdynamic parameters of the system. Figure 1, references 3 Russian.
[150-2415]

STATISTICAL ESTIMATION OF MEAN OPERATING MARGIN FOR AIRCRAFT ENGINE DEPENDING ON CAUSE OF FAILURE

KUZNETSOV, A. Ya, [deceased]

[Abstract] The mean operating margin of an aircraft engine is estimated statistically considering that, given N engines of a certain type in a lot, m of them will fail ahead of schedule while n of them use up their margin and r continue operating "on the wing" till the last inspection. There are k causes of failure, each resulting in m_s failures (s = 1,2,...k) so that $\sum_{s=1}^{k} m_s = m$. For practical purposes such as predicting the reliability and particularizing the maintenance procedures based on "state of engine", one must know the mean margin differentially with respect to each cause of failure. A statistical estimation accordingly will yield the mean margin for engines of a given type if all failures were due to any one of the k causes without any failures due to the other k- 1 causes. The simple weighted average is not a true estimate of failures due to one cause, since it does not include units which are still operating "on the wing" but would fail due to some other than that particular cause. A correct estimate is based on a distribution function F(t) characterizing the failure-free operating time and controlling the margin till failure due to the particular cause. Most suitable is shown to be the Weibull distribution $F(t) = 1- e^{-t^a/b}$, which describes "sudden" or "peak" failures with a = 1 and "gradual" or "wear" failures with $a \neq 1$. In the latter case the mathematical expectation of the operating time margin till failure due to the s-th cause is $M\{\tau\}^{(s)} =$

$= b^{1/a_s} \Gamma(\frac{1}{a_s} + 1)$ with $\Gamma(x)$ denoting the complete gamma function. Estimates of the mean margin have been made on this basis for failure due to abrasive wear of compressor blades, crack formation, improper conditioning of fuel, chips in oil filter, excessive oil consumption, surges, runaway of free turbine, and other causes. References 1 Russian.
[150-2415]

ESTIMATING TECHNICAL STATE OF AIRCRAFT GAS-TURBINE ENGINES FROM
THERMOGASDYNAMIC PARAMETERS WITH NATURAL DISPERSION OF STATE PARAMETERS
TAKEN INTO ACCOUNT

KABESHOV, M. A., SHEPEL', V. T., SOBOL', I. M. and AKHMEDZYANOV, A. M.

[Abstract] The technical state of a gas-turbine engine is estimated from
measurement of thermogasdynamic parameters in service or in test and sub-
sequent analysis, on the basis of a mathematical model, which yields the
deviations of nonmeasurable state parameters from their nominal values with-
in or beyond their natural dispersion. The mathematical model used here is
a linear one: $\delta\vec{Y} = H\delta\vec{X}$ ($\delta\vec{Y}$- vector of deviations of measurable thermogas-
dynamic parameters , δX- vector of deviations of nonmeasurable unknown state
parameters, H- matrix of influence factors). The problem is essentially
one of estimating the state of an object, specifically an aircraft, engine,
on the basis of incomplete information. It is assumed that there is a low
probability of many simultaneous faults in engine components and elements,
a fault being defined as deviation of a parameter from its nominal value
beyond the range of its natural dispersion. The problem is solved by the
method of statistical testing and selecting from an infinite set of solu-
tions a finite set corresponding to basic types in the form of Boolean
vectors ("1" representing parameters deviating into the fault range, "0"
representing all other parameters). The maximum-likelihood estimate is then
selected on the basis of dropout frequency. The algorithm is demonstrated
on a typical case of three measurable thermogasdynamic parameters and a
+0.50% dispersion of independent state parameters. Tables 2, references 2
Russian.
[150-2415]

IMPROVING ROTOR RELIABILITY ON FEED PUMP MOTORS IN 300 MW GENERATING
FACILITIES

INOZEMTSEV, Ye. K., engineer, PRP Rostovenergo

[Abstract] Operating experience with AV-8000/6000UZ motors in electric
power plants has shown that reliability is poor because of leaks that
develop in the system for direct water-cooling of the rotor. A consider-
able number of leaks develop due to failure of the rubber sealing rings.
To improve reliability the radial water lines on some of the motors were
modified by installing plate springs and washers to keep the pressure on

the sealing rings constant regardless of shrinkage during operation. The details of the modification are given. Operational tests show that this technique prevents leaks due to shrinkage of rubber rings, improving reliability of motor operation and reducing labor by extending the period between overhauls to 4-5 years. Figures 3.
[149-6610]

STUDY OF PROPERTIES OF SYSTEM OF TWO-STAGE POWERED GYROSCOPES

VASIL'YEV, V. N., Moscow

[Abstract] The control capabilities of a system of two-stage powered gyro-scope-gyrodynes are characterized by the range of the control moment, W. A determination is made of the relationship between the state matrix, the range of the angular momentum vector, S, and range W. A set of n identical two-stage powered gyroscope-gyrodynes is assumed to be installed on a spacecraft in a random manner. With h_j representing a unit vector directed along the axis of precession of the j-th gyrodyne, the set of vectors h_j defines the arrangement for installation of the gyrodynes on the spacecraft, i.e., the position of the axes of precession relative to the spacecraft's axes. With G_j representing the angular momentum vector of the j-th gyrodyne, the set of vectors G_j characterizes the relative position of gyrowheels and their position in relation to the spacecraft's axes. A change in angles of precession results in a change in state of the gyropropulsion system. The range S depends on the number and installation arrangement of gyrodynes on the spacecraft, and its dimensions are proportional to the angular momentum of the gyrodyne. Range W is the geometrical locus of possible positions of the control moment vector, M. The geometrical shape of range W depends on the state matrix and its dimensions are proportional to the angular momentum of the gyrodyne and the maximum precession velocity, λ. It is demonstrated that range W is a polyhedron whose faces are rhombi. A formula is derived for the general conditions under which the control moment created by the gyrodyne system in random direction r becomes zero. States of the gyropropulsion system in which range W forms only a two-dimensional or unidimensional set are called singular and the W corresponding to them, degenerate. The system of gyrodynes loses its control properties in random direction r if the axis of precession of each gyrodyne, its angular momentum vector and vector r_0 are coplanar. The gyropropulsion system loses its control properties if the axes of precession of all gyrodynes are parallel or the angular momentum vectors of all gyrodynes are mutually collinear. In singular states the gyropropulsion

system can create a control moment only in directions perpendicular to vector r_0 and range W degenerates into a plane figure. Since the volume of W can serve as a measure of the departure of the gyropropulsion system from singular states, the maximum volume of W can be used as a criterion in problems relating to control of a system of gyrodynes. Singular states of the gryopropulsion system form singular points and surfaces within range S and both degenerate and non-degenerate ranges W can be associated with each point. The possibility of the origin of singular states can be eliminated or the probability of their occurrence can be reduced without changing the resulting vector of the gyropropulsion system's angular momentum, because the existence of non-degenerate ranges at singular points makes it possible to regulate the relative position of gyrodynes. Figures 4, references 4 Russian.
[101-8831]

ANALYSIS OF HIGH ORDER DIGITAL TRACKING SYSTEMS ON PHASE PLANE

GORDEYEV, A. A., GAVRILOVA, L. A. and SUVOROV, S. N., Moscow Aviation Institute imeni S. Ordzhonikidze

[Abstract] Equations are derived for a full and complete investigation of digital tracking systems with a continuous portion of any nth order by the phase plane method. The problem is solved by adjusting the initial model to a system of canonical difference equations and subsequent representation of the system as a reduced second or first order system. By analyzing quantitative estimates a number of practical recommendations can be given for parametric synthesis of systems. The approach suggested for DTS analysis is universal, allows full determination of the nature of self-oscillations and determination of quantitative estimates, indicating good effectiveness. Figures 4, references 8 Russian.
[166-6508]

ANALYSIS OF OUTPUT SIGNAL FROM DEVICES MEASURING DEFOCUSING OF LENSES
WITH COHERENT ILLUMINATION

MOSYAGIN, G. M., Moscow Higher Technical School imeni N. E. Bauman

[Abstract] A study is made of the formation of a signal at the output
of a device for measuring the defocusing of a lens. It is assumed that the
test object is struck by flat monochromatic radiation; that the collimator
and test lens have small relative apertures and are diffraction limited
systems. The signal at the output of the radiated energy receiver is
defined with the input aperture fully and partially opened. With the
aperture fully opened, information on defocusing of the lens being tested
is contained in the amplitude of the output signal. With the aperture
partially opened, information on defocusing is contained in its phase.
Figures 2, references 7 Russian.
[166-6508]

AUTOMATION OF OPTICAL SYSTEM PLANNING

RODIONOV, S. A., Leningrad Institute of Precision Mechanics and Optics

[Abstract] The experience of development and application of automatic
planning systems in the area of optics has shown that they are expensive
(requiring up to several hundreds of man years to develop) but rather
quickly pay for themselves by greatly improving the productivity of labor
of designers as well as plan quality. This can, however, be achieved by
taking the systems approach to the creation of automatic planning systems.

The main characteristic differences of automatic planning systems from other methods of using computer equipment to plan optical systems are outlined. They include ideological unity, completeness of the range of tasks performed, automation of the internal functions, organizations of personal designer's archives and a general systems data base, interactive operation, universal and machine independent input language and modular structure. Planning of optical systems can be broken down into synthesis, analysis and optimization, each of which is briefly described. Some problems related to the development of software for automatic optical system planning systems are discussed. Hardware recommended for use in such a system includes the YeS-1045 and YeS-1060 computers with at least 1024 Kbytes RAM. All calculations must be performed in double precision.
[166-6508]

DEVICE FOR MANUFACTURE OF LARGE THIN SPHERICAL MIRRORS

ISAYEV, T. I. and RADKEVICH, I. A., Institute of Theoretical and Experimental Physics, Moscow

[Abstract] A simple method has been developed for manufacturing of large mirrors under laboratory conditions, which can in principle be used to manufacture aspherical mirrors. A sheet of acrylic plastic is clamped together with a sheet of aluminum between two flanges, with one side of the glanges open, the other closed. The assembly is heated by a 500 W light bulb to the softening point of the plastic, at which time air is injected on the closed side, causing the plastic and aluminum to bulge in the opposite direction. The bulb is then turned off, and the plastic retains its shape when it cools. The authors have used this method to manufacture spherical mirrors 2 mm thick and 750 mm in diameter, using aluminum sheets 2 to 3 mm thick as the elastic support to give the plastic its desired shape. The required pressure was 0.75 to 1.0 atm. To avoid edge effects the thickness of the membrane should be smoothly decreased to a few tenths of a millimeter near the flange. Figure 1, references 4: 2 Russian, 2 Western.
[151-6508]

NANOSECOND X-RAY FRAME IMAGE CONVERTER BASED ON MICROCHANNEL PLATE

ARANCHUK, L. Ye., AYVAZOV, I. K., BOGOLYUBSKIY, S. L., VOLKOV, G. S.,
ZAYDEL', I. N., PEREVODCHIKOVA, G. I.

[Abstract] A nanosecond x-ray frame electronic-optical recorder based on a
microchannel plate is described. The device can be used to measure the
radiation of z-micropinches created in the diode of a powerful relativistic
electron beam generator, the "Triton". The microchannel plate, which has
good sensitivity for radiation at wavelengths of 2-2000 A (quantum yield
5 to 10%) is the main element of the instrument. The gain in sensitivity
achieved by the use of a microchannel plate converter to record monochromatic
radiation is estimated. The instrument is now being used to prepare a
system for multiframe photography. An image of an object obtained with an
exposure of 4 ns by means of the device is presented. Figures 4,
references 4: 2 Russian, 2 Western.
[151-6508]

PROGRAMMED APPARATUS ADJUSTMENT CONTROL DEVICES IN LASER OPTICAL SYSTEMS

ALLIN, A. P., BYKOVSKIY, N. Ye., GRIGOR'EV, V. Ye., IVANOV, V. V.,
SENATSKIY, Yu. V., SKLIZKOV, G. V., SHPILEVOY, B. N., YUZHAKOV, A. N.
and YAKUSHEV, A. K., USSR Academy of Sciences, Physics Institute, Moscow

[Abstract] A description is presented of a study of the characteristics
of a hardware set for automatic adjustment of a laser beam used in the
"Del'fin" nuclear fusion apparatus. Photographs and a diagram of the
elements of the apparatus are presented. The characteristics of the auto-
matic adjustment system were studied by menas of a secondary beam from a
gas helium and neon laser with a divergence of 20" introduced colinearly with
the beam of a garnet laser. A flow chart of the laser mirror adjustment
cycle program is presented. The system is used as the basis for the computer
controlled laser adjustment subsystem of the "Del'fin" installation, used
to automatically adjust the elements which transport the laser beam through
the optical path from the master laser to the power amplifier output stages.
Figures 4, references 9: 7 Russian, 2 Western.
[151-6508]

SHADOW INSTALLATION TO STUDY TRANSPARENT OPTICAL HETEROGENEITIES UNDER VIBRATION CONDITIONS

KOROLEV, A. N., NAUMOV, B. V. and VOLOVA, I. N.

[Abstract] The shadow installation described uses an optical system practically eliminating the influence of displacement of optical elements resulting from vibration on the operation of the device. The trace of two rays from a beam from the diaphragm is tracked to illustrate the operation of the device. The installation is tested and found to have clear advantages over ordinary installations for recording of shadow diagrams where vibration is present. Figures 3, references 6 Russian.
[151-6508]

SEMICONDUCTOR CONVERSION ELECTRON SPECTROMETER WITH β-BACKGROUND SUPPRESSION

VISHNEVSKIY, I. N., ZHELTONOZHSKIY, V. A., SVYATO, V. P. and TRISHIN, V. V., Institute of Nuclear Studies, Ukrainian Academy of Sciences, Kiev

[Abstract] A semiconductor internal conversion electron spectrometer with suppression of the continuous β-particle background is described. A very thin silicon surface-barrier detector with negligible gamma radiation photon recording effectiveness is used, improving the selection of true β-e_K coincidences and suppressing the continuous β-particle background by about 40 times for ^{111}Ag and ^{105}Ru nuclei. The spectrometer can also measure individual internal conversion electron spectra, e_K-gamma coincidences and e_K-gamma angular correlations. A diagram of the spectrometer is presented. The spectrometer was used to measure the conversion spectra of the electrons of ^{77}Br, ^{106m}Ag, ^{104}Ag, ^{109}In and ^{110m}In. Figures 3, references 6: 5 Russian, 1 Western.
[151-6508]

ANNIHILATION PHOTON ANGULAR DISTRIBUTION ANALYZER BASED ON IMAGE CONVERTER

ZHAVORONKOV, V. I., MOKRUSHIN, A. D., BAKULIN, V. N., OSOKIN, K. P. and
SYUTKIN, V. M., Kirov State Pedagogic Institute

[Abstract] An angular distribution analyzer based on an image converter
equipped with a scintilator and operating in the time trap mode is con-
sidered quite promising. The burst developing in the scintilator as a
result of absorption of one of two photons from electron-positron annihila-
tion is amplified to a level sufficient to record the spot on the output
screen and preserve information on the coordinates of the spot. The con-
verter also operates as a time trap open for about 10^{-7} s as a result of the
impulse from the other annihilation radiation photon. The open time of the
trap determines the background level of random coincidences. A functional
diagram of the device is presented. The analyzer would allow improvement
in the methods of measurement of the angular distribution of annihilation
photons, the basis of many works on the study of the electron structure of
matter. Figures 2, references 3: 2 Russian, 1 Western.
[151-6508]

MINIMIZING CURRENT LOSSES IN ELECTRON CYCLOTRON INJECTION SECTION

ANOSOV, V. N., DENISOV, Yu. N., KHIKMAN, Z., LINNEMAN, V. Yu. and
PICH, G., Joint Institute for Nuclear Research, Dubna

[Abstract] A method is suggested to optimize the operation of a charged
particle accelerator to minimize current losses in the injection section.
The method was tested in the injector of the electron cyclotron at the
nuclear problems laboratory, Joint Institute for Nuclear Research. The
system is controlled by a YeS-1010 computer and in 50% of cases achieves
a current loss 7% less than manual adjustment. Four injector parameters
are used to optimize the current of the beam at the output of the repeater:
focusing coil current, electrostatic voltage and voltages of the rotary
capacitor. The algorithm selected is simple, convenient to use and operates
stably regardless of variations in current functions during search for the
extremum. Figures 5, references 9: 4 Russian, 5 Western.
[151-6508]

HEAVY ION ACCELERATOR

LOGACHEV, Ye. I., REMNEV, G. Ye. and USOV'YU, P., Scientific Research
Institute of Nuclear Physics, Tomsk Polytechnical Institute

[Abstract] A heavy ion accelerator based on an explosive emission plasma
created at the anode before the accelerating voltage is fed to the gap is
described. A bipolar pulse generator is suggested to implement this approach.
When the first negative pulse is fed to the potential electrode of the diode
(working as a cathode) an explosive emission plasma arises, including ions of
the electrode material. Then a positive polarity pulse is fed to the
potential electrode and the ions are repelled from the plasma and accelerated
in the diode. Bipolar operation of a high current accelerator using an
explosive emission plasma as the ion source expands the range of elements
which can be used to obtain accelerated beams of ions. The ion current can
be increased by suppressing the longitudinal electron component of the bi-
polar flux in the acceleration gap using known methods for pinching the
electron beam and reflector systems. Figures 3, references 7: 4 Russian,
3 Western.
[151-6508]

CHANGE OF NULL SHIFT IN RING LASER CAUSED BY DIFFRACTION

MASLENOK, Ye. D. and MYNBAYEV, D. K.

[Abstract] The beat frequency of a ring laser is described by the expression
$f_b = K_0 + K_1\omega + K_{-1}\omega^{-1}$ (ω- measurable angular velocity, K_{-1}- nonlinearity
coefficient, K_1- scale factor, K_0- null shift generally caused by a combina-
tion of effects). The effect of diffraction on the null shift is analyzed,
assuming the resonator to be perfectly tuned at the instant of laser turn-on
and to expand uniformly during heat-up. Concurrent action of the perimeter
stabilizing system and the power stabilizing system causes displacement of
the compensating mirror on a piezoceramic base and, consequently, readjust-
ment of the resonator. As a result, the diffraction loss increases and the
gain per pass decreases. A four-mirror ring laser is considered, with a
spherical mirror and with a "quadratically" nonlinear medium partly occupying
the nearly confocal resonator cavity. With the expression for the null
shift or diffractional split of frequencies of opposing waves in such a
resonator as basis, the change of this split due to changes in diffraction
loss and in gain is evaluated by the method of sensitivity analysis. The

BROADBAND INTERFERENCE FILTERS

MARKOV, Yu. N., NESMELOV, Ye. A. and GUSEV, A. G.

[Abstract] Use of multicomponent periodic dielectric structures $(G(ABCCBA)^m$
and $G(ABCDDCBA)^m$ as broadband interference filters (G- substrate with refrac-
tive index n; A,B,C,D- quarter-wavelength layers with refractive indexes
n_A, n_B, n_C, n_D respectively, m- period repetition index, λ_0- principal wavelength)
is feasible with $n_B = \sqrt{n_A n_C}$ for a three-component filter and $n_A n_D = n_C n_B$ for
a four-component filter. The basic characteristics of each, namely profile
and width of the transmission band, are here determined analytically, using
the angle spectrum of the transmission coefficient, i.e., the geometric mean
of its envelopes as the spectral characteristic. Also the reverse problem
of determining the relations between the refractive indexes from given trans-
mission band characteristics is solved, through solution of a third-degree
or fourth-degree (depending on the number of components) algebraic equation
by the Descartes-Euler method. Theoretical results obtained by numerical
evaluation on a computer are compared with results of experiments, using as
examples a four-component coating for a 0.3-1.7 μm passband with $\lambda_0 = 0.5$ μm
$(A = MgF_2, B = ThF_4, C = La_2O_3, D = ZnO_2)$ and a three-component coating for
two reflection bands separated by a wide 2.1-8.35 μm transmission band
$(A = PbF_2, B = As_2S_3, C = As_2Te_3)$. The experimental specimens were produced
by resistive vacuum evaporation of the components on KCl substrates.
Figures 5, references 5; 3 Russian, 2 Western.
[157-2415]

DEPENDENCE OF BEAT FREQUENCY IN RING LASER ON PERTURBATIONS OF DISCHARGE
CURRENT

TUCHIN, V. V. and CHETVERIKOV, V. I.

[Abstract] A neon-helium ring laser with circularly anisotropic resonator
is considered, such a laser being capable of generating a difference
frequency as a result of interaction of two oppositely traveling waves of an

applied longitudinal magnetic field. Such a laser can be built in a small size with large gain margin, it can also operate with a monoisotopic active medium. Its main disadvantage is high sensitivity of the beat frequency to oscillations of the discharge current, owing to dispersion of the activating transition and to absorbing transitions at nearby frequencies. Here both effects are analyzed, the latter contributing up to 10% of the total frequency deviation. The frequency due to dispersion and the degree of current modulation are first calculated as functions of the relative pumping level, for quasi-steady laser operation with a center-tuned resonator. These calculations are based on an approximation of the plasma dispersion function and a quadratic algebraic equation for the current with parameters approximately corresponding to conditions of experiments. The frequency deviation increases with increasing relative excitation level, its trend of this calculated relation being very sensitive to form of approximation used for the plasma Z-function. The frequency deviation decreases with increasing discharge current. It increases almost linearly with rising beat frequency, over a wide range of discharge current above nominal. Measurements made for the purpose of segregating the frequency deviation data by sign (+,-) and subsequent linear approximation of the data according to the method of least squares have made it possible to separate its two components; additive and multiplicative. The authors thank S. S. Skulachenko, I. I. Savel'yev and L. A. Mel'nikov for discussing the results. Figures 3, references 10: 9 Russian, 1 Western.
[157-2415]

SCATTERING INDICATRICES OF LASER MIRRORS

PETRUKHIN, Ye. A. and SAVRANSKIY, S. A.

[Abstract] Multilayer interference coatings of various dielectric materials are widely used for mirrors in laser resonators. Since absorption of light by such coatings is negligible, only scattering determines the loss of light during reflection. The scattering indicatrices of such reflecting materials (ZnS and Na_3AlF_6 deposited by resistive vacuum vaporization, ZrO_2-SiO_2 deposited by electron-beam vacuum vaporization, TiO_2-SiO_2 deposited by cathode sputtering) as well as of other reflecting materials (silver, aluminum, gold films vacuum deposited on fused quartz, polished silicon and germanium wafers) were measured, for the purpose of comparative evaluation and correlation with various theories regarding the role of surface roughness. THe measuring equipment consisted of a long-wave laser ($\lambda = 0.6328$ μm), modulator, beam splitter, diaphragm, goniometer, photomultiplier, tuned amplifier, synchronous detector, photoreceiver of reference signal from the synchronous detector, and a recording instrument. As model of a reflecting surface was

selected a plane rough surface with random distribution of asperities and discrete distribution of scattering centers, the latter in the form of large individual defects producing "forward" peaks on the indicatrix. The parameters of surface roughness were estimated by comparing the diffuse parts of indicatrices measured for two incidence angles, 10° and 45°, with indicatrices calculated on the basis of dielectric spheres as model of scattering centers. This yielded for all materials a correlation radius of 2000-4000 $\overset{\circ}{A}$, with the rms height of asperities ranging from 10 $\overset{\circ}{A}$ on ZnS and Na_3AlF_6 coatings (13 layers) to 25 $\overset{\circ}{A}$ on TiO_2-SiO_2 coatings (13 layers) and 3 $\overset{\circ}{A}$ on silver coatings. Figures 4, table 1, references 11: 1 Russian, 10 Western.
[157-2415]

VARIANT FACET-TYPE REFLECTOR DESIGN WITH VARIABLE GEOMETRY

SHCHERBAKOV, Yu. K., Moscow Higher Technical School imeni N. E. Bauman

[Abstract] Elastic deformation of sheet material is an effective method of producing double-curvature mirrors with controllable optical and electrical characteristics for solar radiation reflectors. One variant of this method of forming facets with variable geometry is based on solving a nonlinear inverse problem in the theory of shallow shells, namely determining the static and geometric constraints as well as the external loads under which a given shape will evolve. The design procedure according to this theory has been developed for and applied to deformation of circular, square, triangular, and trapezoidal plane sheet segments into spherical and nonaxisymmetric paraboloidal facets. An experimental evaluation by the moire method has confirmed the correctness of such a design. The accuracy of the design improves as a concentrated bending moment is replaced with a larger number of equivalent and uniformly spaced equal bending moments. Figures 2, references 8: 6 Russian, 2 Western.
[165-2415]

TOLERANCES ON PARAMETERS OF FACET ELEMENTS IN CONCENTRATOR ARRAYS

KHODZHAYEV, A. Sh., ZAKHIDOV, R. A. and KLYCHEV, Sh. I., Central Design
and Planning Office of Scientific Instrument Building, UzSSR Academy of
Sciences

[Abstract] Design of facet elements for concentrator arrays is considered
from the standpoint of tolerances on their focal parameter, concentrator
performance requirements setting the upper limit and technological feasi-
bility setting the lower limit on that dimension. The range of this
dimension for one standard facet size and the zones within a concentrator
frame to be carrying facets of one standard size are determined, with the
radiant flux impinging on a receiver of given dimensions as the design
criterion. The procedure is to first fix the linear dimensions and the
planform of a facet, as well as its location on the concentrator frame, then
vary the curvature of its reflecting surface and thus the focal parameter.
The radiant flux incident on the receiver surface in the focal plane of the
array is calculated for each value of the focal parameter. The focal param-
eter of a facet is optimum when the radiant flux is maximally concentrated
for given reflection coefficient and dimensions of the receiver surface.
Calculations are made in a rectangular system of coordinates, and are shown
here for a paraboloidal concentrator frame. The tolerance field is estab-
lished for five standard facet sizes, corresponding to five aperture angles.
The number of standard facet sizes for a given concentrator aperture can be
determined and minimized from the results of these calculations. It is
also possible to estimate, on this basis, the contribution of the various
concentrator zones to the overall performance. Figures 4, references 1
Russian.
[165-2415]

OPTICAL SYSTEM FOR HELIOSTAT ORIENTATION

BARANOV, V. K. and MEDVEDEV, V. Ye., "Order of Lenin" and "Order of
October Revolution" STate Institute of Optics imeni S. I. Vavilov

[Abstract] An optical system for heliostat orientation has been developed
which uses a standard solar radiation transducer in front of the panel
without imposing more stringent requirements on the design of the heliostat

structure. It includes another transducer, under the heliostat panel, and a pair of plane instrument mirrors, one semitransparent, with auxiliary optics at the center of the panel for redirecting the sun rays as required to the two transducers. The auxiliary optics can be an array of prisms or a concentric hemispherical lens with mirror coating on the lower part of the convex surface facing the outside transducer, no coating on the upper part of the convex surface facing the sun, and a semitransparent coating at the center of the plane surface facing the transducer underneath on the heliostat pedestal. The lens version is simpler than the prism version, requiring fewer components, and can be designed for minimum aberration and high accuracy. Figures 3, references 2 Western.
[165-2415]

PHOTOSENSITIVITY OF n^+-p-p^+ PHOTOVOLTAIC CELL ILLUMINATED ON THE p-p^+ SIDE AS FUNCTION OF p^+-LAYER PARAMETERS

ANOSHIN, Yu. A., BORDINA, N. M. and ZAYTSEVA, A. K., "Order of Labor's Red Banner" All-Union Scientific Res arch Institute of Current Sources

[Abstract] An experimental study of photovoltaic cells with n^+-p-p^+ structure and bilateral photosensitivity was made with illumination on the p-p^+ side, for the purpose of determining their electrical characteristics (short-circuit current) on parameters of the p-p^+ layer. Specimens of such photovoltaic cells were built on p-type silicon with <III> orientation, electrical resistivity $\sigma = 7.5$ ohm·cm, and diffusion path for minority carriers at least 500 μm long. The doped n^+-layer was produced by diffusion of phosphorus from PCl_3 in a carrier-gas stream and the p^+-layer was produced by diffusion of boron from a boron-silicate glass film containing 30% B_2O_3. In one experiment the thickness of the p^+-layer was varied by stepwise removal of thin slices. In the second experiment the doping level of the p^+-layer was varied by diffusion of boron under various conditions (temperature ranging from 950 to 1000°C, time ranging from 3 to 15 min, cooling rate ranging from 3 to 150 °C/min). An evaluation of experimental data, and theoretical calculations based on the spectral distribution of the current collection coefficient, reveal that the necessary minimization of the effective base surface area through reduction of the p^+-layer thickness to approsimately 0.1 μm is most effectively attainable when the p^+-layer includes a thick heavily doped ($p \geq 10^{20}$ cm^{-3}) surface sublayer and thus has a nearly rectangular impurity concentration profile. Figures 3, table 1, references 6: 2 Russian, 4 Western.
[165-2415]

UNIVERSAL NEUTRON IRRADIATOR BASED ON ^{252}Cf

BAK, M. A., deceased, KRIVOKHATSKIY, A. S., NIKOLAYEV, V. A.,
STSIBORSKIY, B. D. and SHIRYAYEV, B. M.

[Abstract] Extensive use of the method of activation analysis on neutrons
of different energy requires sources with different neutron energy spectra.
It is more efficient and convenient to use a single irradiator with average
energy and energy spectrum that can be varied simply and rapidly in the
region of exposure of specimens. The authors describe a laboratory irradiator
based on ^{252}Cf developed for such a neutron source. The neutron energy
spectrum in the irradiation cavity is formed by selecting the necessary
combination of hydrogen-containing moderator placed around the vials of
californium and the specimen to be exposed, and adjusting the distance
between them. The irradiator is made up of three coaxial cylinders. The
inner cylinder and the spaces between cylinders can be filled with a neutron
moderator such as water. Six metal vials of ^{252}Cf are placed on special
holders in the inner cylinder. The total possible mass of californium is
100 µg. Distribution in six containers gives a more uniform neutron field
in the center of the irradiator. Biological shielding is provided by an
outer layer of moderator to attenuate the neutron flux, and a layer of
lead to attenuate gamma rays. When working with low-intensity neutron sources,
the layer of lead between the inner and outer cylinders can be removed, and
the space filled with moderator or left empty. A mechanical transmission
is provided for moving the californium radially symmetric with the center
by a calibrated dial. Total mass of the irradiator is about 1 metric ton.
Figures 2.
[148-6610]

NEW SYNCHROTRON COMPLEX AT RADIUM INSTITUTE IMENI V. G. KHLOPIN

PERFILOV, N. A., SHILOV, V. P., EYSMONT, V. P., AUSLENDER, V. L.,
LAZAREV, V. N. and FAKTOROVICH, V. L.

[Abstract] A report on a new synchrotron complex for energy of 50 MeV/nucleon
constructed at the Radium Institute imeni V. G. Khlopin in Leningrad.
In addition to the cyclotron, the complex includes large experimental
facilities and systems for automating control of the accelerator and of
experiments on it. The new synchrotron has been developed for producing

beams of accelerated protons and completely ionized atoms (Z/A ≅ 0.5) in continuously controllable ranges of 10-200 and 0.3-50 MeV/nucleon respectively. The output beams are monoenergetic within at least 1% with current pulse duration of 20 μs and pulse recurrence rate of 50 Hz. The intensity of the extracted proton beam is up to 10^{11} particles per second, and for multiply charged ions--at least 10^8 particles per second. The synchrotron is a weakly focusing ring with four straight runs and equilibrium orbit radius of 1.4 m. Rotating-focusing magnets and particle input-output system are accommodated inside a common vacuum-tight chamber with outside diameter of about 4.2 m. The average vacuum on the synchrotron orbit is $6.7 \cdot 10^{-5}$ Pa (about $5 \cdot 10^{-7}$ mm Hg). Injection is from a pulsed r-f linac. Proton energy at the injector outlet is 1.5 MeV, and ion energy is 0.6-1 MeV/nucleon at Z/A ≅ 0.5. The M-6000 computer is currently being sued for accelerator control. In the future, the SM-2 computer control complex is to be used. The synchrotron complex is to be put into operation in 1984. Figure 1, references 14: 13 Russian, 1 Western.
[148-6610]

FLUID MECHANICS

UDC 621.438.001.5

PHYSICS OF SEPARATED FLOW IN END ZONES OF TURBINE BLADING

Moscow ENERGOMASHINOSTROYENIYE in Russian No 1, Jan 83 pp 11-13

CHERNYSHEV, L. L., candidate of technical sciences

[Abstract] Experimental data are given on the aerodynamic characteristics
of separated flow at the ends of the blades of a turbine straight blade
cascade. The stator of the second stage of the GTK-10 turbine was used
to model the cascade, which has geometrical dimensions of 90 mm for the
length of a blade, 116 mm for the chord dimension, a spacing of 114 mm and
an outlet angle of 27 degrees, with an S435 profile. Parameters in the
cascade were measured with a laser Doppler rate meter and acoustical measure-
ments were performed. Measurements were made of the frequency of the separa-
tion of vortexes from the convex portion of the blade's profile and of the
noise spectrum and level with various initial conditions of flow in the
blade cascade described and in a cascade with low baffles installed in the
channels between blades for the purpose of reducing secondary flows.
The most promising way of increasing the economic efficiency of a turbine
stage is to reduce the energy dissipation coefficient in the secondary
flow zone. Secondary flows are responsible for pulsating flow at the ends
of blades. The installation of low baffles, which reduce the amount of
fluid taking part in secondary motion and, consequently, in the formation
of separated flow in the corner zone formed by the convex portion of the
profile and the face surface, is an effective method of reducing losses from
secondary flows. The installation of baffles 10 mm high in the cascade
studied along the lines of flow resulted in an average of a 15 to 25 per-
cent reduction in the energy dissipation coefficient in the end zone. With
the installation of baffles the frequency of the separation of secondary
flow vortexes is reduced approximately twofold and its energy is no longer
predominant against the overall background. Secondary flows are reduced
considerably and undesirable separation phenomena on the convex portion of
the blade profile are eliminated. There is an increase in the number of
small vortexes, which rapidly dissipate. Figures 3, references 6 Russian.
[145-8831]

ASYMPTOTE OF ORR-SOMMERFELD EQUATION SOLUTIONS DEFINING UNSTABLE OSCILLATIONS WITH LARGE REYNOLDS NUMBERS

ZHUK, V. I. and RYZHOV, O. S., USSR Academy of Sciences Computer Center, Moscow

[Abstract] A multilayer flow structure corresponding to known asymptotics of upper and lower branches of a neutral stability curve was studied in an earlier work; based on linearized Navier-Stokes equations, the model used allowed analysis of higher approximations with Reynolds numbers approaching infinity. The present article constructs solutions in each area including the critical layer arising in the linear stability problem and produces dispersion relationships both for neutral oscillations and for disturbances with exponentially increasing amplitude. Figure 1, references 10: 6 Russian, 4 Western.
[176-6508]

PROPAGATION OF SHOCK WAVES THROUGH LIQUID WITH GAS BUBBLES

SHIKHMURZAYEVA, Z. A.

[Abstract] Two problems pertaining to propagation of strong transient shock waves through a liquid containing gas bubbles are analyzed on the basis of a one-velocity two-temperature model of such a medium. The corresponding equations of mass and momentum conservation, thermal flux equation, and Rayleigh-Lamb equation take into account radial motion of bubbles as well as heat dissipation. The first problem is interaction of short-wave pulses, it has been solved by numerical simulation for two colliding solitons. The second problem is interaction of long-wave pulses with a bubble shield and their reflection by a solid wall. This problem has been solved by physical simulation and mathematically, assuming a linear acoustic medium whose motion can be described by linear wave equations for velocity and pressure. The problem, formulated for a pulse of infinite length, is: with pressure and velocity at the contact boundary given, determine the pulse in the one-phase liquid which induces wave flow in the two-phase liquid. The solution to this problem reveals the damping characteristics of a bubble shield, such a shield being capable of gradually raising the pressure at the wall. The author thanks R. I. Nigmatulin and A. I. Ivandayev for their interest and helpful discussions. Figures 3, references 9 Russian.
[106-2415]

AERODYNAMIC CHARACTERISTICS OF DELTA WING AT SUBSONIC FLIGHT VELOCITIES

VORONIN, V. I.

[Abstract] A thin delta wing is considered flying at subsonic velocity
in an ideal incompressible medium with separation at the nose. The aero-
dynamic characteristics of such a wing are calculated by the method of vortex
grids: both leading and trailing vortex sheets simulated by filaments of
discrete vortices, the wing replaced by an array of orthogonal longitudinal
and transverse apparent vortices. The problem is solved in a rectangular
system of coordinates, with the boundary condition of impermeability satisfied
at apparent vortices and control points in the grid. The aerodynamic load
is determined from the circulations with application of the Zhukovskiy
theorem "in the small". The dependence of the normal pressure coefficient
at the Mach number $M = 0$ on the angle of attack has been evaluated for various
wing opening angles from 90 to 180° with a sweepback angle of 60°, its
dependence on the sweepback angle has been evaluated for various angles of
attack from 5 to 15° and wing opening angles from 120 to 180°. These
theoretical results indicate that the normal pressure coefficient decreases
as the wing opening angle increases, decreasing more with larger angles of
attack. They compare with experimental data obtained at $M = 0.2$ for two
delta wings, one with a sharp nose and one with a cylindrically rounded
nose. Figures 3, references 4 Russian.
[106-2415]

EFFECT OF PARTICLES IN GASEOUS SUSPENSION ON GAS PARAMETERS DURING FLOW
AROUND BLUNT BODY

YENIKEYEV, I. Kh.

[Abstract] A monodisperse gaseous suspension of spherical solid particles or
liquid drops is considered flowing around a flat plate placed transversely
in the stream. Both subsonic flow and supersonic flow are analyzed in this
case, assuming the volume concentration of particles to be negligibly low.
The system of differential equations of motion for a two-velocity two-
temperature medium, closed by the equations of state for both phases with
interphase energy transfer taken into account, have been solved through
numerical integration by the O. M. Belotserkovskiy--Yu. M. Davydov method

of large particles for a certain set of boundary conditions. These include
symmetry of the stream, no penetration of gas through the plate, and no
reflection of particles by the plate back into the stream (colliding
particles assumed to vanish from the stream). The results indicate that
the presence of particles in the gas stream holds the shock wave closer to
the plate and raises the pressure at the stagnation point. They also indi-
cate that there is a range of values of controlling parameters within which
the density of the gas decreases from the shock wave to the plate surface.
The author thanks professor R. I. Nigmatulin and professor Yu. M. Davydov
for discussing the problem and the results. Figures 4, references 5:
4 Russian, 1 Western.
[106-2415]

PROCESSES OF FILLING MAIN PIPELINE WITH LIQUID

BERDNIKOV, V. V., KOZYREVA, T. S. and PANTYUKHIN, B. A.

[Abstract] Flow of liquid fuel from a vertical tank to an engine through
a horizontal pipeline, upon rupture of a membrane in the pipeline not far
from the tank, is analyzed taking into account "hammer" during the transient
period of pipeline filling with liquid. The liquid is assumed to be in-
compressible and not to mix with the air it displaces from the pipeline as
the liquid column propagates. The mathematical model is based on Bernoulli's
law for variable velocity of the liquid and the first law of thermodynamics
for variable mass and pressure of the air. The condition for maximum pres-
sure surge is established, namely zero air flow rate in plugged pipeline,
and three dimensionless criterial similitude parameters are established
which determine the height and the width as well as the timing of the
pressure peak during the pipeline filling process. Numerical calculations
have been made for a 1.52 m long pipeline 0.034 m in diameter filling with
a liquid of 1600 kg/m^3 density from a tank with constant pressure of 3.6 MPa,
after rupture of a membrane in the pipeline 0.07 m away from the talk dis-
charge orifice and under a pressure of 0.1 MPa on the air side. Figures 4,
references 2 Russian.
[150-2415]

TRANSIENT METHOD OF STUDYING HEAT TRANSFER IN COOLING CHANNELS FOR TURBINE BLADES

ISKAKOV, K. M. and TRUSHIN, V. A.

[Abstract] The transient method of heat transfer study is applied to gas turbines, this method requiring less time and simpler equipment for the experiment than methods based on steady-state and regular modes of heat transfer. The procedure is demonstrated on determination of local heat transfer coefficients in a rectangular slot channel under conditions of turbulent flow of cooling air. Air is fed to the channel through a duct split into two parallel ones: one with a cutoff valve and an electric resistance heater, one with a throttle valve and a flow meter. Temperatures along the cooling channel are measured by probes with thermocouples. The heat transfer coefficients at locations of the probes at successive instants of time are calculated from temperature and flow data, with known specific heat of air. Figures 3, references 5 Russian.
[150-2415]

FLOW PATTERN IN SEMICLOSED SPACES OF STEM VALVES AND DISCHARGE CHARACTERISTICS OF SUCH DEVICES

ZAYKOVSKIY, V. N., ZAULICHNYY, Ye. G. and PODLYATSKIY, V. G.

[Abstract] An experimental study was made of the air flow pattern in stem valves, particularly in the "pocket" space. The discharge characteristics of such a device were measured as a function of gate lift height at the entrance, with the stem position varied from all the way up to all the way down closing the exit orifice. The velocity of incoming air was varied over the 30-200 m/s range, with the Reynolds number referred to inlet velocity and stem diameter remaining within $(1.1-3.25) \cdot 10^5$. The pressure was measured with a Class 0.5 manometer, the discharge was measured with a flow meter using a throttle disk. The temperature of incoming air was held at 268 K, the stagnation pressure was maintained constant at 8.55 kgf/cm^2. The results, numerical data and photographs revealing an intricate three-dimensional flow pattern, are interpreted in terms of formation of parallel and criss-cross vortex trails according to the Karman theory. The discharge coefficient is calculated as the ratio of real flow rate G to ideal flow rate $G_i = 0.3965FP*/\sqrt{T*}$ (F- area, P*- stagnation pressure, T*- stagnation

temperature) through an exit orifice 45 mm in diameter. Figures 7,
references 7 Russian.
[150-2415]

UDC 662.997

HYDROMECHANICAL DESIGN OF DRAINAGE SYSTEM IN SOLAR HEATING PLANT

RASHIDOV, Ty. K., Tashkent Zonal Scientific Research Institute of Experimental
Design of Residential and Communal Buildings

[Abstract] A drainage system has been developed and built by the authors
for protection of solar radiation collectors against freezing during shut-
down of the circulation pump. The hydromechanical design of the system is
based on economical selection of pipe diameters for transport of the heat
transfer agent (water with air bubbles in suspension without separation of
the air from the water). Two loops extending above the "full" level of the
expansion tank on top and including a drain tank at the bottom separate the
solar radiation collector with pump from the heat storage tank with boiler-
booster and heating appliances. The breather pipe in this loop, between vent
and drain tank, is selected judiciously without unnecessary calculations.
The venturi pipe between pump and drain tank is designed carefully, and the
circulation pump is selected among available ones with the performance curve
best matching the requirements. The design procedure, based on Bernoulli's
and Darcy's equations, has been applied to a solar heating plant for a six-
room single-story rural residential dwelling in the village Mingchinar in the
Tashkent oblast (Galabinsk district), where the heating system consists of
24 solar radiation collectors in four horizontal tiers of six with water flow-
ing to the heating appliance at a rate of 0.686 kg/s at a mean temperature
of 50°C. Total height of the solar radiation collector array is 10 m and
circulation of the heat carrier requires a power of 98 W, for which a TsVTs
25-2 pump has been selected. Figures 2, table 1, references 9 Russian.
[165-2415]

RELATIONS FOR DESIGN OF HEAT EXCHANGER EQUIPMENT IN SOLAR HEATING PLANTS

POZ, M. Ya., IL'IN, V. P., KOGAN, D. Ya. and AVEZOV, R. R., Tashkent Zonal
Scientific Research Institute of Experimental Design of Residential and
Communal Buildings, and Physico-Technical Institute imeni S. V. Starodubtsev,
UzSSR Academy of Sciences

[Abstract] Operation of solar heating systems is characterized by transient
modes of heat transfer associated with diurnal changes in climatic conditions.
Engineering estimates are often made adequately on the basis of steady-state
relations, which are most conveniently put in dimensionless form. Here
such relations are compiled for use in the design of heat exchanger equipment.
The three systems considered are: 1) single-loop (direct) arrangement of
"tubes on sheet" solar radiation collector and water-air heat exchanger or
heater in the room; 2) two-loop arrangement of solar radiation tank; 3) two-
loop arrangement of solar radiation collector in a heat storage tank.
Figures 2, references 2 Russian.
[165-2415]

DEPENDENCE OF EFFICIENCY OF THERMORECEIVER IN LOW-TEMPERATURE SOLAR HEATER
ON THERMAL CONTACT RESISTANCE BETWEEN SHIELD AND HEAT REMOVING CHANNELS

AVEZOV, R. R. and KAKHAROV, N. A., Physico-Technical Institute
imeni S. V. Starodubtsev, UzSSR Academy of Sciences

[Abstract] The equations of heat balance are set up for a heat exchanger
with round heat carrying tubes in grooves of a corrugated radiation absorb-
ing shield made of sheet metal. Consideration is taken of the thermal
contact resistance between tubes and shield, assuming a contact line circular
in cross section. These equations are used to calculate the thermo-
receiver efficiency and the ratio of contact resistance to contact width
as functions of the mean contact thickness, with either air or a heat con-
ducting adhesive as interlayer, also the thermoreceiver efficiency directly
as a function of that ratio. The results indicate that the efficiency
remains twice as high with a semicircular contact than with a full circular
contact up to some critical contact thickness, which depends on the outside
diameter of the tubes, insofar as the effect of radiative heat transfer is
more significant than the effect of thermal contact resistance. Numerical

data for a low-temperature solar heater operating in ambient air at 45°C illustrate this relation. Figures 2, reference 1 Russian.
[165-2415]

SAIL THEORY

BRUTYAN, M. A. and KRAPIVSKIY, P. L.

[Abstract] The problem of undetached flow of an ideal incompressible fluid around a sail is considered. The flow is taken as planar and steady. In contrast to previous studies in which the stress arising in the material was considered constant, the authors make a more realistic assumption of a non-linear relation between stress and relative elongation. In dimensionless variables the solution of the problem depends on two parameters: the angle of attack α and the Weber number $\lambda = 2\rho U^2/f$, where ρ is density, U is velocity at infinity, and f is a coefficient of proportionality between stress and relative elongation. An asymptotic solution is sought as $\lambda \to 0$ at arbitrary α. The shape of the sail $y = F(x)$, $0 \le x \le 1$ is determined from a system of two integrodifferential equations with boundary conditions $F(0) = F(1) = 0$. The first equation relates the velocity distribution over the sail to its shape, and the second expresses Laplace law. The Zhukovskiy formula gives an expression for the lift. Solutions are found for limiting cases of $\alpha \gg \lambda^{1/2}$ and $\alpha \ll \lambda^{1/2}$. Figures 3, references 3 Western.
[139-6610]

VIBRATIONS OF CAPACITOR PLATES UNDER ALTERNATING VOLTAGE

SHAFOROSTOV, V. Ya., engineer, and PETRENKO, L. G., candidate of physical
and mathematical sciences

[Abstract] Under alternating voltage Coulomb and electrodynamic forces
which vary periodically over time act on the plates of a capacitor and cause
the plates to vibrate. Resonance takes place when the frequency of variation
of these forces matches the natural frequency of vibration of the plates, and
the amplitude of vibrations increases resulting in mechanical damage to the
dielectric and lowering of the voltage for the beginning of partial discharges.
Conditions for resonance are greater with trapezoidal voltage, which has a
broader frequency spectrum, then with sinusoidal voltage. Capacitors under
trapezoidal voltage have a shorter life. Amplitudes of vibrations of plates
and resonance frequencies are calculated and the conditions under which
the vibrations of plates are minimal are determined for the plates of a flat
capacitor, based on calculation of Coulomb and electrodynamic forces. A
model of a plane rectangular membrane fastened at two opposite ends was
chosen for calculation and vibrations are described by a second-or er
differential equation agreeing with the equation for vibration of an elastic
string. Calculated values of resonance frequencies were compared with
experimental data for a flat capacitor with aluminum foil plates 40 micrometers
thick, 100 mm long and 45 mm wide. One plate was fastened to a fabric-base
laminate wafer and was securely fixed, while the other was wound onto it with
spacing of 100 micrometers and tension of 5 N. Alternating voltage whose
frequency varied from 0.4 to 4.2 kHz was applied to the capacitor plates and
the sound vibrations originating when the plates vibrated were converted by
means of an electromagnetic microphone pickup into voltage, which was
registered by an oscilloscope. The experimental data proved to be close
to the calculated values of resonance frequencies. In order to reduce the
vibrations of capacitor plates, sections should be designed so that the
operating frequencies are not resonance frequencies for them. This can be
achieved by proper selection of the relationship between the tension of the
plates when sections are wound, their length and the viscosity of the impregnat-
ing material. Movement of plates when they vibrate is reduced considerably

with an increase in the density with which sections are wound, with an in-
crease in the viscosity of the impregnating material. Compositions which
harden after impregnation, such as epoxy compounds, are best. Incomplete
impregnation and settling of the impregnating material in hardening result
in the formation of pores in the vicinity of which plates vibrate with con-
siderably lower amplitude and higher frequencies than in non-impregnated
sections. In order to reduce pores, it is advisable to impregnate the
dielectric first with a liquid composition, briefly, and then with a
hardening composition for a longer time. The pores are then filled with
the liquid impregnating material rather than with air when the compound
hardens. Figures 3, references 2 Russian.
[119-8831]

ELECTROMAGNETIC FORCES IN CONICAL RADIAL THRUST ELECTROMAGNETIC BEARING

ZHURAVLEV, Yu. N., candidate of technical sciences, Pskov Branch,
Leningrad Polytechnical Institute

[Abstract] A study is made of electromagnetic forces in a conical radial
thrust electroma netic bearing whose magnetic circuit consists of a conical
journal fastened to a shaft and a stationary stator with a tapered bore.
The journal and the stator's steel are made of electrical sheet steel and
the stator has eight identical uniformly spaced poles. The poles' windings
contain an identical number of turns and form four electromagnetic loops,
each with its own current, whereby the first loop contains poles 1 and 2,
the second poles 3 and 4, etc. The magnetomotive force of adjacent poles
in adjacent loops has the same direction in order to reduce losses from
reversal of magnetization. It is assumed that it is possible to disregard
the steel's reluctance, that the field in the gap is plane-parallel, that
it is possible to disregard the magnetic energy of eddy currents in the
journal, that the journal is a non-deformable solid of correct geometrical
shape with six degrees of freedom, that displacements of the journal are
minor as compared with the gap, and that it is possible to disregard leakage
flux. It is assumed that the system of electromagnetic forces is counter-
balanced by another system of forces of non-electromagnetic origin. An
expression is derived for two kinds of variable forces and characterizes
the controlling force influence of the loops on the journal and position
forces representing the destabilizing influence on the journal of the
magnetic field in the gap. Expressions are derived for self-inductances and
the influence of the leakage flux of the poles on the self-inductances of
the loops and on electromagnetic forces is discussed. The magnetic flux
linkage of each loop with its own leakage flux is six times greater than the
magnetic flux linkage with the leakage flux of neighboring loops, and there
is practically no magnetic flux linkage with leakage flux of an opposite
loop. The leakage factor of the poles is in the range of 0.02 to 0.03. The

data of the theoretical study were verified with a special apparatus enabling independent movements of the journal along five coordinates. Loop inductances were measured by the induction pulse method. The results obtained can be used in static and dynamic calculations of electromagnetic bearings and rotor machines. Figures 3, references 1 Russian.
[119-8831]

REACTION OF THREE-LAYERED CYLINDRICAL SHELL TO ACTION OF NON-AXISYMMETRIC MOVING LOAD

POZHUYEV, V. I., Zaporozh'ye

[Abstract] A study is made of the reaction of an infinitely long 3-layered cylindrical shell to the action of a non-axisymmetric load moving along the axis at a constant speed which is slower than the rate of propagation of shear waves in the filler. For a subcritical speed the distribution of displacements and contact stresses is arrived at for a system of forces uniformly distributed over the circumference, and the influence of the thickness and rigidity of the filler on the deflections of the shell and on contact stresses is demonstrated. Dynamic equations of the theory of elasticity in vector form are used for the filler. Equations are written for non-axisymmetric motion of the bearing layers and it is assumed that the filler contacts the shells along their middle surfaces owing to the small thickness of the bearing layers. Boundary condtions are written for the case of sliding contact and bilateral constraint. A moving system of coordinates is used and discussed first is a unit normal load with random dependence on the angular coordinate, which varies along coordinate η sinusoidally and moves at a constant speed along the outer shell. Normal loads which are transmitted to the filler from the casings are found. A solution is found to equations of motion for the filler in a moving system of coordinates. A formula is arrived at for determining radial displacements in the filler. Expressions are found for displacements and stresses in the filler. Figures 4, references 8: 7 Russian, 1 Western.
[101-8831]

DAMPING OF ELASTIC VIBRATIONS OF STRUCTURES WITH LIQUID

BUZHINSKIY, V. A. and MIKISHEV, G. N., Moscow

[Abstract] Devices are discussed for damping transverse and longitudinal
vibrations of structures with a liquid. The hydrodynamic damper for trans-
verse vibrations is in the form of a rigid shell fastened by means of
elastic ties to the walls of the compartment containing the liquid. The
elastic ties permit the shell to move in the radial direction and the compart-
ment is connected to the walls by means of thin elastic diaphragms at the
ends of the shell. The annular space thus formed is leakproof and filled
with gas. The liquid interacts with the damper's shell in transverse vibra-
tions of the compartment. As a result of this the shell performs relative
transverse vibrations, and a considerable portion of the liquid is set in
motion. The hydrodynamic damper for longitudinal vibrations is in the form
of two coaxial bellows with a common rigid top at their ends and is fastened
to the bottom of the compartment with the liquid. The annular space formed
by the walls of the bellows, the top and the bottom is leakproof and filled
with gas and the space formed by the walls of the inside bellows, top and
bottom is connected with the main mass of liquid by means of holes in the
top. Periodic variation of the volume of the damper's spaces takes place
with longitudinal vibrations of the compartment and a considerable portion
of the liquid contained in the compartment is set in relative vibrational
motion. Hydrodynamic vibration dampers of this sort have low weight, since
a liquid is used in them as the moving mass. Equations are derived for
vibrations of structures with hydrodynamic dampers. The problem is dis-
cussed of limiting the amplitudes of transverse and longitudinal vibrations
of thin-walled structures with a liquid. It is shown that the devices pro-
posed are highly effective. Some results of experimental studies are given,
in particular of forced axisymmetric vibrations of a cylindrical shell with
a hydrodynamic damper. Under specific conditions, strong damping of vibra-
tions of a shell with a liquid is achieved by using a device of the sort
described whose volume equals only 0.1 percent of the volume occupied by the
liquid. Figures 8, references 8 Russian.
[101-8831]

STRESSED STATE OF ROTATING RIBBED DISK OF COMPLEX CONFIGURATION IN PRESENCE
OF HOLES AND CRACKS

VOLKOV, N. I. and FIL'SHTINSKIY, L. A., Sumy

[Abstract] The problem is discussed of the stressed state in a disk
weakened by holes and cracks and strengthened by stiffening ribs in a field
of centrifugal forces. It is assumed that the disk can have a non-circular
border but that its geometry has a recurring symmetrical structure. The
problem is formulated as follows: Let an isotropic disk weakened by a
recurring symmetric system of n holes and slits and also stengthened by
radial stiffening ribs rotate with constant angular velocity. It is assumed
that the ribs are continuously fastened to the disk along radial lines and
are situated symmetrically in relation to its middle plane and are in
tension-compression. The complete border of the disk consists of simple
closed (outside border and holes) and open (cracks) contours with continuous
curvature. Stresses in the disk are represented as $\sigma_{ik} = \sigma_{ik}^{(0)} + \sigma_{ik}^{(1)}$, where

$\sigma_{ik}^{(0)}$ represents stresses caused by the action of centrifugal forces and

$\sigma_{ik}^{(1)}$ represents additional perturbations caused by the presence of stress

concentrators and ribs. Additional displacements and stresses are expressed
in terms of the two analytical functions $\Phi(z)$ and $\Psi(z)$ of complex variable z.
Expressions are found for functions $\Phi_3(z)$ and $\Psi_3(z)$, which take into account
the presence of cracks and, assuming that the total border of the disk is
free from forces, boundary conditions are found and the boundary problem is
reduced to a mixed system of regular and singular integral equations which
are solved numerically on a computer. A parametric analysis is made of co-
efficients of the intensity of stresses and of the stressed state in danger
zones of the disk. Results of calculations are given for a rotating steel
disk. Figures 5, references 6 Russian.
[101-8831]

FREE ROTATION OF AIRCRAFT AS RIGID BODY

NELYUBOV, A. I., Moscow

[Abstract] The results are presented of studies of free rotation of an
aircraft as a rigid body. These results have a practical application in

studying conditions of motion with negligibly low external moments in the process of vertical takeoff and landing of aircraft, in flight with low aerodynamic moments and in the flight of spacecraft in free space. Problems are solved relating to the nature of the change in an aircraft's angular velocities and angular position in space over time and of the interrelationship between the initial state of the aircraft, its inertial properties and characteristics of subsequent motion. Equations for free rotation of an aircraft as a rigid body are written most simply in Eulerian form, in projections onto the principal central axes of the Poinsot ellipsoid. The aircraft's angular position is determined by Eulerian angles, i.e., the angle of roll, yaw angle and pitch angle, which are measured by sensors on the aircraft and are related to angular velocities by means of kinematic relations. Rotation of a rigid body around the axis with the lowest moment of inertia or with the highest moment of inertia is stable in the Lyapunov sense with respect to the angular position of axis 1 or 2, while rotation of a rigid body around the axis with the middle moment of inertia is not stable with slight perturbations of initial angular velocities for the other two axes. The conditions are given for preferred rotation of the body around the axis with the lowest moment of inertia and the highest moment of inertia, in terms of initial angular velocities. Solutions are given to the Euler free rotation equations for the case of preferred rotation of the aircraft around the axis with the lowest moment of inertia and the highest moment of inertia. The solutions are considerably simplified by the introduction of a number of assumptions which have been substantiated by the results of a previous study of free rotation of a rigid body. First-approximation equations are directly integrated and sufficiently simple relationships are arrived at, in elementary functions, between the initial conditions, the relationship between moments of inertia and the rates of variation of motion parameters. Oscillations of the yew angle and pitch angle, with predominant rotation of the aircraft around the axis with the lowest moment of inertia are characterized by low frequencies, and their amplitudes are determined basically by the initial angular velocities. For preferred rotation around the axis with the highest moment of inertia, the amplitudes and frequencies of oscillations $\omega_1(t)$ and $\omega_3(t)$ are determined by the initial conditions and relationship between moments of inertia, and the amplitudes and frequencies of oscillations of the bank angle and pitch angle are determined by the initial conditions for Eulerian angles and by the mean rotational speed, $<\omega_2>$. For the case of rotation of the aircraft with high angular velocity around the axis with the middle moment of inertia the approximate solutions differ considerably from the precise. Figures 5, references 8 Russian. [101-8831]

PROGRAM LEVEL OF CONTROL SYSTEM FOR WALKING DEVICE WHEN MOVING AT ASSIGNED SPEED

BERBYUK, V. Ye., L'vov

[Abstract] Studies are continued on arranging for energetically optimal movement of a two-legged walking device supplied with actively controllable stops. Dynamic conditions of walking are studied with an assigned speed and with the existence of a double-support movement phase. A plane 7-element model of a 2-legged walking device is discussed and equations are given for its movement along a horizontal surface, written in the form of Lagrange equations of the second kind. The elements stimulating the device's stops are assumed to be weightless and inertialess. With t_ν representing the start of a random ν-th single step and (1/2)T representing the duration of a single step, so that $t_{\nu+1} = t_\nu + (1/2)T$, and τ is the duration of the 2-support phase, i.e., the phase of support on both legs simulataneously, in time segment $t_\nu \le t \le t_{\nu+1} - \tau$, movement of the device takes place with support only on one of its legs, and in time segment $t_{\nu+1} - \tau \le t \le t_{\nu+1}$, with support on both legs simultaneously. The device's walking is defined as the cyclic repetition of single steps caused by the action of control moments in its joints and by forces of the support's reaction. A serial algorithm is arrived at using finite formulas for computing control moments in the joints of the legs and the reaction forces of the support under whose influence assigned motion of the device is made possible, for the case of movement of a device having both single-support and 2-support phases of movement. Estimates are given for the expenditure of energy in 2-legged walking. A parametric optimization problem is given, whose solution makes it possible to construct the program level for a control system for the device when it moves at an assigned speed with various gaits with a 2-support phase, and also makes it possible to find the optimum value of the duration of the 2-support phase. Figures 5, references 10: 9 Russian, 1 Western.
[101-8831]

MAXIMUM CAPABILITIES OF ELASTOINERTIAL VIBRATION PROOFING

RYABOY, V. M., Moscow

[Abstract] With an increase in the degree of vibration proofing in a specific frequency range, the ratio of the total mass of a passive elastoinertial

vibration proofing construction to its static rigidity, m/c, increases indefinitely. A precise quantitative expression is found for this relationship. Estimates are obtained which describe the maximum capabilities of an entire set of linear passive elastoinertial vibration proofing systems with any structure and any finite number of degrees of freedom. The problem on which the discussion is based is to find the lowest possible value of the total mass, m, of a unidirectional linearly elastic system having specific static rigidity, c, and having a gain factor $r(\omega)$, in a given excitation frequency range, ω $(\omega_- \leq \omega \leq \omega_+)$, which does not exceed the assigned value of ε, i.e., $|r(\omega)| \leq \varepsilon$, $\omega_- \leq \omega \leq \omega_+$. This problem is reduced out of considerations of dimensionality to finding the relationship between three dimensionless parameters, $(m/c)\omega_-^2$, ω_+/ω_-, and ε, of the type $m_{min} =$ $= (c/\omega_-^2)\phi(\omega_+/\omega_-, \varepsilon)$. Approximate analytical expressions are found in closed form for function ϕ with sufficiently high accuracy. It is found that a linear relationship exists only between two dimensionless combinations of these parameters, which describes with high precision the maximum capabilities of an entire class of linear elastoinertial vibration proofing systems with lumped parameters. The system is assumed to consist of n material points elastically coupled with a rigid base and with one another. It is assumed that the material points of the system can be displaced in only one direction. The system's elastic properties are described by a positive definite matrix of rigidity of the general type with dimensions of n X n. The system's vibration proofing properties are characterized by the gain factor, which is equal to the ratio of the amplitudes of the harmonic force acting on the base and of the harmonic external force acting on the system's "input," i.e., mass m_1 and of the base with kinematic excitation on the base end. An expression is found representing the lower estimate of $(m/c)^{1/2}$ for any elastoinertial system satisfying the vibration requirements indicated. It is shown that this estimate makes it possible to consider more complicated variants of the requirement that $|r(\omega)| < \varepsilon(\omega)$, where ω is a member of the vibration proofing frequency set. Figure 1; references 8 Russian.
[101-8831]

STABILITY OF SPINNING OF RIGID BODY WITH FLEXIBLE ELEMENTS

DOKUCHAYEV, L. V. and KLISHEV, O. P., Moscow

[Abstract] A theoretical study is made of the stability of free spinning of a supporting rigid body taking into account dissipation of energy in vibrating elastic elements. In previous studies regions of stability were plotted for rods arranged along the principal axes of an aircraft. Here precise regions are plotted for asymptotic stability of the spinning of an aircraft with two oblique elastic rods, and an analysis is made of the

influence of the angle at which the rods are installed on alteration of the region of stability. Necessary and sufficient conditions are found for stability of a non-trivial equilibrium position of the rods inclined at a random angle to the body's spinning axis. The motion of a rigid body of specific mass with flexible elements attached to it is discussed. It is assumed that external forces and moments do not act on the body and that it moves translationally and is spinning, and that the flexible elements perform slight elastic vibrations. Equations of motion are derived for the body, taking into account deformation of the flexible elements, as well as for the acceleration, static moment and angular momentum vectors and the inertia tensor. Equations of steady motion are solved for unperturbed motion and a study is made of the stability of the solution. Flexible elements are discussed in the form of two identical, homogeneous and inextensible rods of specific length stuck in the body and forming specific angles with one of its axes. Increasing the angle at which the rods are installed from 0 to 90 degrees considerably reduces the region of stability. With this angle greater than 50 degrees, the rotational velocity must not be higher than the first natural vibration frequency of the rods. The natural vibration frequency of flexible elements and the permissible rotational velocity increase with an increase in the stiffness of the rods. The results of calculations of the boundaries of regions of stability are compared for an object with two flexible elements placed along its spinning axis and perpendicular to it. Figures 4, references 8; 3 Russian, 5 Western.
[101-8831]

UDC 621.923.005

TECHNOLOGICAL CONSIDERATIONS IN RATIONAL SELECTION OF SETUP SCHEME AND PROCESSING MODE FOR ROUGH GRINDING OF BODIES OF REVOLUTION

KAMALOV, V. S., candidate of technical sciences, BURMISTROV, V. V., candidate of technical sciences, and GUSEV, V. V., graduate student

[Abstract] Rough grinding of parts made of glass-crystalline composite materials is considered, a peculiarity of this process applied to bodies of revolution such as cylinders being formation of a parting cone around the wheel. Grinding with the wheel axis crossing the cylinder axis has been proposed for maximum utilization of the cutting surface and thus maximum productivity of the process. Here the effect that such a geometry and the corresponding kinematics have on the technological parameters is analyzed on the basis of two experiments, a second-order noncomposite one and a full factorial one. The wheel orientation is defined in terms of two angles: α (0-40°) between wheel axis and direction of axial feed, β (0-3°) between

directions of axial feed and radial feed. A second-degree regression equation is derived for the specific energy content of the grinding process (ratio of effective power to productivity) as function of these two angles and the depth of cut at constant speeds of the cylindrical part in a lathe and constant rates of axial feed. This equation is further modified to power and logarithmic-exponential relations describing the energy content and the precision of the grinding process as functions of those three parameters as well as of cylinder velocity and axial feed rate. Evaluation of data obtained in a 1K62 lathe with a grinding head driven by a 2.2 kW motor indicate that a setup with crossing axes is expedient for standard PP wheels with diamond grains in the surface layer. Figures 3, references 5: 4 Russian, 1 Western.
[108-2415]

GEOMETRICAL DISPERSION AND DAMPING OF WAVES IN LAMINATE COMPOSITE MATERIALS

SHUL'GA, N. A. and LEVCHENKO, V. V., Institute of Mechanics, UkSSR Academy of Sciences

[Abstract] Geometrical dispersion and damping of electromagnetic volume waves in a regular laminate composite material are calculated analytically and numerically. The corresponding boundary-value problem for harmonic waves in a boundless medium is first solved exactly, assuming that the Maxwell field equations are satisfied in a stack of layers of generally different thicknesses and with different but constant magnetic permeabilities, dielectric permittivities, and electrical conductivities. The reolvent equations for waves which are not functions of the transverse coordinate split into two independent congruent groups of equations for H-modes and E-modes which, on the basis of the boundary conditions for the field vector components, can be reduced to an infinite system of algebraic equations. The latter are solved for waves propagating parallel to the layers and for waves propagating obliquely across the stack, assuming the layers to be isotropic. The transmission zones in the (ω, k)-plane are thus determined, with energy losses first disregarded and then taken into account. The dispersion equations for arbitrary frequency and loss tangent can be solved by numerical method only. Article was presented by Academician A. N. Guz', UkSSR Academy of Sciences. Figures 3, references 4 Russian.
[107-2415]

SYNCHRONIZATION LAW FOR UNBALANCED VIBRATION EXCITERS

BELKHMAN, I. I. and PIRTSKHALAISHVILI, O. G., All-Union Scientific Research and Design Institute of Mechanical Processing of Minerals, Leningrad

[Abstract] In addition of other already established laws governing the synchronization of unbalanced vibration exciters, another one is considered here according to which the condition for stability of synchronous rotation of the exciter rotors depends largely on the directions of their rotation. This law is demonstrated on a simple system consisting of a solid body free to perform plane parallel motion mounted on a stationary base through a set of vertical springs and set in vibration by four identical mechanical exciters. These exciters, each consisting of an unbalanced rotor, are located pairwise symmetrically with respect to the center of gravity of the body. Their directions of rotation are assumed to be arbitrary. Conditions of their synchronization stability are analyzed for various combinations of initial phases and senses of direction (s = 1 clockwise, s = -1 counterclockwise): in two modes of linear vibrations and in two modes of purely angular vibrations, also for three combinations corresponding to no vibrations in the case of balance of centrifugal forces. The results of this analysis should be useful for foundation design. Figure 1, table 1, references 2 Russian.
[109-2415]

PROPAGATION OF LONGITUDINAL ELASTIC WAVES THROUGH BEAM SURROUNDED BY WINKLER MEDIUM

FILIPPOV, A. N.

[Abstract] Propagation of longitudinal elastic waves through a semiinfinite beam with uniform circular cross section is considered in the case where such a beam interacts with a surrounding Winkler medium according to the law of dry friction (friction force proportional to beam strain). The equation of longitudinal motion for this elastic beam is formulated with a zero initial condition, namely the beam at standstill making free contact with the medium. The equation, after conversion to dimensionless variables, is solved exactly by the method of Laplace transformation for two kinds of boundary condition at the end of the beam. The first one corresponds to a

load force which does not decrease in time (strain $\frac{\partial u}{\partial x} = -f(t) \geq 0$ at $x = 0$,

t- time, x- longitudinal coordinate). The second one is kinematic, the rate of change of beam length being a known function of time $(\frac{\partial u}{\partial t} = h_1(t) \geq 0$ at

$x = 0$). In both cases the pulse length is assumed to be much larger than the radius of the beam cross section. The study was done under guidance of professor V. S. Lenskiy. References 3 Russian.
[106-2415]

STRESSED-STRAINED STATE OF SHELL STRUCTURE WITH VISCOELASTIC FILLER OF ARBITRARY FORM

BULGAKOV, V. K., AL'YES, M. Yu. and LIPANOV, A. M.

[Abstract] Algorithms are constructed for calculating the stressed-strained state of an aircraft engine. They are based on solution of the nonlinear problem of stress and strain for a body made of viscoelastic and isotropic non-aging material with nontrivial shell geometry under an arbitrary surface pressure load with boundaries which move as a result of fuel depletion. The problem is solved by the methods of finite elements and successive loading. Thermal effects are disregarded and the stress-strain field is assumed to remain quasi-steady during changes in pressure or movement of the boundaries. The determining system of stress and strain tensor equations, with the elasticity tensor as parameter and with the regular part of the relaxation kernel, is reduced to the hyperelastic model with moduli varying in time and then to a system of nonlinear algebraic Ritz equations in "Lagrangian" coordinates. Various approximations are tried for the linear operator in the displacement iteration so as to ensure maximum convergence of the process and stable solutions with maximum accuracy. The procedure has been programmed in FORTRAN-4 for a computer. It is demonstrated on a thin shell structure with low-modulus weakly compressible filler of intricate shape in a plane state of strain. Figures 5; references 6 Russian.
[150-2415]

CALCULATING INTERSECTING CYLINDRICAL SHELLS UNDER INTERNAL PRESSURE

AMENZADE, Yu. A., associate member, AzSSR Academy of Sciences, MAYDEL'MAN, V. N. and TEPLOV, G. D., Machine Building Plant imeni Lt. Shmidt

[Abstract] An analysis is made of systems of homogeneous shells consisting of long intersecting cylindrical surfaces. The line of intersection is approximated by a circle. An applied method of shell calculation is used [see Sh. M. Aliyev, V. N. Maydel'man, G. D. Teplov, "Abstracts of Papers at Eleventh All-Union Conference on Theory of Plates and Shells", Khar'kov, 1977; STROITEL'NAYA MEKHANIKA I RASCHET SOORUZHENIY, No 5, 1978, pp 19-24]. The solution is first found for the main shell with openings, and for the throat without consideration of conditions on the edge of the openings. The main system for the shell with openings and for the throat is taken as elementary rings cut off by planes perpendicular to the longitudinal axes of the shell. Complete radial displacements are taken as the unknown functions for both shells. Solutions are found for the effect of internal pressure on the intersection of two circular cylindrical shells and for the intersection of a flattened oval shell and a circular cylindrical shell with axis coincident with the minor axis of the oval. The condition on the edge of the opening is satisfied by a method of rms approximation. The results of the calculations agree well with experimental data. Figures 2, references 5: 4 Russian, 1 Western.
[140-6610]

INVESTIGATION OF INFLUENCE THAT CONFIGURATIONAL PARAMETERS OF QUADRIC CRANK MECHANISMS HAVE ON KINEMATIC AND FORCE CHARACTERISTICS OF FORMED SIX-BAR LINKAGES

DZHAVAKHYAN, R. P. and BORISENKO, A. I., Yerevan Polytechnical Institute imeni Karl Marx

[Abstract] The authors study the effect that angles of the kinematic and force grouping of quadric crank mechanisms have on the extremum values of the analog of acceleration of the output link and force parameters of a six-bar linkage. Problems are solved relating to synthesis of six-bar linkages in accordance with conditions of minimizing maximum accelerations of the output link, and optimizing the action of the planned linkage on the pedestal. It is shown that the separate minimization of the total force,

the principal moment of forces loading the pedestal of the six-bar linkage and the necessary driving moment can reduce their maximum values by respective factors of 1.25, 1.41 and 1.13 as compared with the initial linkage. Simultaneous minimization of reactions in fixed hinges gives better results from the standpoint of action on the pedestal. Figures 2, table 1, references 5: 2 Russian, 3 Western.
[141-6610]

TESTING AND MATERIALS

METHOD OF NUMERICAL CALCULATION OF TEMPERATURE FIELDS OF COMPLEX BODIES

BUT'KO, Ye. F., PARFENOV, V. G. and SIGALOV, A. V., Leningrad Institute
of Precision Mechanics and Optics

[Abstract] The literature contains many effective difference systems for
solution of the nonsteady equations of heat conductivity in complex shape
areas. Application of known difference systems may lead to significant
programming difficulties in the creation of the library and great diffi-
culty in its use. The need therefore arises to develop new approaches -
methods for using known difference systems to facilitate the construction
of subroutine libraries. This work analyzes the problem of developing such
a method and a library of routines for the class of areas consisting of
the conjunction of rectangular parallelepipeds with right triangular prisms,
corresponding to widely used optical crystals. The method described for
using difference systems allows relatively simple implementation of a
library of subroutines to calculate the temperature fields in crystals,
which can be used to model the temperature fields of complex thermostated
shapes in the design of thermostats. In a simple computation it was
found that the divergence between calculated results using different systems
did not exceed 10%, the greatest difference being observed at the initial
moment in time. Refinement of temperature at the contact area need not
be performed. Use of an explicit form to calculate preliminary values of
temperature on the contact surface places no serious limitations on
stability. Figures 3, references 5 Russian.
[166-6508]

EXPERIENCE IN VACUUM TREATMENT OF PRECISION INSTRUMENT COMPONENTS

Leningrad SUDOSTROYENIYE in Russian No 1, Jan 83

PRIBYLOV, V. A.

[Abstract] A vacuum device is described which serves for degassing the surfaces of precision instruments on gas bearings and thus protecting them against contamination and failure. It consists of a degassing chamber, a sorption trap, a mechanical pump and a pair of TsVA-1-2 zeolite pumps, one in a Dewar flask and one in a heater. Auxiliary equipment includes a manometer, six valves, two nickel-mesh filters, and two exhausts. Both degassing chamber and the sorption trap are made of Kh18N10T stainless steel, the sorption trap consisting of two cells with activated carbon stain-less steel, the sorption trap consisting of two cells with activated carbon in the lower one and 5A zeolite in the upper one. This combination of sorbents ensures high selectivity as well as reliability and long life. For treatment the degassing chamber is hermetically closed and a ready zeolite pump is placed in the flask with liquid nitrogen at $-196°C$. After operation this zeolite pump is removed from the flask and heated to room temperature, then regenerated by means of the heater. Treatment with this device removes sorbed gases to a residual pressure of $1 \cdot 10^{-3}$ mm Hg, but much lower partial pressures, without using oil and thus without contaminating the treated surfaces with oil vapor and its cracking products. Figures 3, references 3 Russian.
[110-2415]

OPTIMIZATION OF OPTICAL AND THERMOPHYSICAL PROPERTIES OF COATINGS FOR SOLAR BATTERIES WITHOUT SELF-FIELD

Tashkent GELIOTEKHNIKA in Russian No 1, Jan-Feb 83
(manuscript received 2 Jun 82) pp 3-5

LIDORENKO, N. S., RYABIKOV, S. V., DALETSKIY, G. S., KOZLOV, A. I., KOLTUN, M. M., MATVEYEV, V. P. and NIKIFOROVA, M. V., "Order of Labor's Red Banner" All-Union Scientific Research Institute of Current Sources

[Abstract] A recent innovation in solar energy converters is tandem bilateral cells with imbedded electrostatic field transparent to infrared radiation. Use of clear radiation-protective heat-regulating optical coatings ensures high efficiency and long life. When such solar batteries are installed on spacecraft, it becomes necessary to suppress their intrinsic electromagnetic field so as to prevent distortion of instrument readings during passage through charged-particle and radiation belts around the earth. The magnetic component can be suppressed by arranging the electrical

connections between cells so that adjacent conductors carry current in opposite directions. The electric component can be suppressed only by use of transparent electroconductive coatings on the outside surface of radiation-protective glass, interconnecting them electrically and "grounding" them to the spacecraft housing. Coatings for this purpose are made of such materials as SnO_2, In_2O_3, and mixtures of these two oxides (10% SnO_2 + 90% In_2O_3), deposited by various methods (ion-plasma sputtering in argon atmosphere, electron-beam vacuum evaporation, chemical pulverization). They are used in solar batteries installed on various reserach satellites: U.S. "Explorer-31" and "Geos", Soviet-Bulgarian "Interkosmos-Bolgaria 1300", Soviet-French "Oreol-3" ("Arkad-3" project). Figure 1, table 1, references 8: 6 Russian, 2 Western.
[165-2415]

REWINDING STATORS OF ELECTRIC MACHINES WITH VES-2 INSULATION

GUGLIN, V. A. and YUZHNYY, Yu. E., engineers, TsKTBER VPO Soyuzelektroremont

[Abstract] A technique is described for updating electric machines by rewinding stators with VES-2 insulation: glass micanite LSK-110 ST tape impregnated with thermosetting compound and baked under pressure. The material has good electrical, mechanical and thermophysical properties, ensuring high reliability of windings. Conditions of installation and heat treatment are detailed. The proposed technique has been used on a number of hydrogenerators and turbogenerators, resulting in 10-15% power increase.
[149-6610]

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